CALIFORNIA STATE MINING BUREAU.

WILLIAM IRELAN, JR., STATE MINERALOGIST.

EIGHTH ANNUAL REPORT

OF THE

STATE MINERALOGIST.

FOR THE YEAR ENDING OCTOBER 1, 1888.

SACRAMENTO:
STATE OFFICE : : : J. D. YOUNG, SUPT. STATE PRINTING.
1888.

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CONTENTS.

To the Honorable R. W. Waterman, *Governor:*

Sir: The Trustees of the State Mining Bureau herewith submit their report, in pursuance of the Act of the Legislature, entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau, approved April 16, 1880,'" approved March 21, 1885.

Respectfully,

J. Z. DAVIS.
S. HEYDENFELDT, Jr.
GEORGE HEARST.
W. S. KEYES.
G. W. GRAYSON.

October 1, 1888.

REPORT OF TRUSTEES OF THE STATE MINING BUREAU.

Prior to the last session of the Legislature the Mining Bureau was not enabled to accomplish much geological work in the field. By the Act approved March 9, 1887, providing for the support and maintenance of the Bureau for the thirty-ninth and fortieth fiscal years, the sum of $60,000 was appropriated, and the Act provided that at least 50 per cent of this appropriation should be used for geological field work. In accordance therewith the Trustees and the State Mineralogist have employed as many assistants in the field as the appropriation would allow, and we are confident that their work has been well and carefully done.

The Bureau has become better known to the residents of the State of California, and its usefulness is becoming more apparent. The Trustees aim to make it most practical, uniting scientific as well as educational features.

A permanent exhibition of both the metallic and earthy minerals will serve to teach by examination and comparison, and will also show the vast wealth of the State in its mineral deposits.

The Trustees are of the opinion that the Museum should always remain in a building as centrally located as the present one. The miners of the State, and those about to engage in mineral enterprises, would undoubtedly prefer it to remain where it is at present, until a larger building can be secured.

The report of the State Mineralogist will be submitted with this short report. This report only shows the condition of the Bureau, its increase in minerals, books, etc., and a statement of its receipts and expenditures. In order to carry out the objects of the Act establishing the Bureau, the Trustees must recommend that the appropriation be increased, and that the sum of $150,000 for the next two fiscal years would enable the State Mineralogist to do more practical and effectual work in the field, and inform the people of the United States and all parts of the world of the great variety of deposits of valuable minerals existing in this State.

MUSEUM.

Since the issue of the last report there has been a large increase of specimens; nine hundred and forty-six having been classified and placed in the Museum, and a larger number unclassified, which are on exhibit, and many others stored. It was therefore very necessary that the Museum should be enlarged, and a gallery has lately been built on the north side. Seventeen cases have been added, but they will not be sufficient to hold the steadily increasing material, which is being constantly received.

The classification of the Museum has been continued under the system heretofore adopted by the present State Mineralogist. It is found to be most satisfactory in easily affording an opportunity to the visitor to find any desired specimens without assistance from the officers of the Bureau.

VISITORS TO THE MUSEUM.

Over twenty thousand names appear on the register of the State Mining Bureau Museum for the year ending October 1, 1888, showing an increase of seven thousand since the report of 1887. This number only represents those who have registered, a large number of visitors failing to enter their names in the book kept for that purpose. In the fifth year of its existence they numbered three thousand six hundred and seventy-six; in the sixth year, four thousand four hundred and seventy-five; in the seventh year, thirteen thousand; in the eighth year, over twenty thousand.

FACILITIES FOR RECEIVING SPECIMENS.

The Trustees appreciate the generous services of Wells, Fargo & Co. in continuing to transport packages (weighing less than twenty pounds) free from all parts of California and the neighboring States and Territories. We are also pleased to acknowledge the courtesy of Goodall, Perkins & Co., who have frequently transported specimens and large samples to the Bureau free of all expense and charge.

List of Donors to the Museum from October, 1887, to October, 1888.

Aaron, C. H.
Aegerter, Wm.
Alameda Pottery Company.
Allen, C. F.
American Salt Company.
Arens, W.
Atkins, R. D.
Attwood, Melville.

Bachelder, C.
Bailey, D. D. & Bro.
Bailey, H. R.
Ball, A. Everett.
Barnes, Edward.
Barstow, C. B.
Barton, John.
Bazet, D.
Belding, O.
Big Bend Tunnel and Mining Company.
Blanc, A.
Blanchard, Milton E.
Boggs, E.
Bowers, S.
Bradley, J. H.
Braverman, M.
Breakfield, A. H.
Britain, Geo. W.
Brown, Wm. Q.
Bruckerman, Frederick.
Brumagin, Miss M.
Bugbee, P. J.

Callahan, H. B.
Caire, Justinian.
Capron, John G.
Chapin, W. C.
Cherry, Edgar.
Chever, Edward E.
Clark, F. Lee.
Clark, Fred. L.
Coe, John R.
Crawford, A.
Crossman, J. H.
Cruikshank, W. D.
Cunningham, E. E.
Curran, Mrs. M. K.
Curtis, J. M.
Cushing, W. H.

Dana, A. W.
Daniel, J.
Davidson, Geo.
Davis, J. Z.
Davis, Geo.
Day, Mrs. H. H.
Depew, Matthew.
Du Bois, P. C.
Duncan, W. E.
Dundee, Chas.

Edwards, Morton A.
Eldridge, J. W.
Elliott, T. J.
Engels, H. A.

Farish, J. B.
Ferguson, C. E.
Field, J. T.
Fischer, E.
Fleming, E. L.
Fletcher, C.
Frank, H. C.
Frost, L. L.

Gauthier, A.
Gibbs, C. V. S.
Gibson, R.
Goodall, Perkins & Co.
Gough, A. P. W.
Greatzer, Frank.
Green, Judge P. D.
Grover, H.
Grundy, Frederick.
Guttman, D.

Hague, Captain C. J.
Hamilton & Co.
Hanbury & Garvey.
Hausman, F. H.
Heydenfeldt, S., Jr.
Hitchcock, J. L.
Howard, Frank.
Howland, B. F.
Huff, Stanley.

Ingham, A. H.

Johnson, J. A.
Johnston, William D., M.D.
Johnston & Son.
Jones, E. W.

Keeler, Captain J. M.
Keil, O.
Kelly, Charles.
Kelley, J. M.
Keyes, W. S.
Keystone Mining Company.

La Bonte, F. X.
Landström, G.
Lane, Dr. L. C.
Leek, Dr. G. W.
Lewis, L. J.
Lightner, Daniel.
Lindgren, W.
Lindsey, W. E.
Littell, W. A.
Loot, S. T.
Loring, F. H.
Los Angeles Granite and Brownstone Company.
Lowe, William M.
Ludwig, John D.

Marks, Joseph.
Markson, P.
Maxwell, J. W. C.
Mayebashi, Y.
Menzel, William.
Metzger, C. L.
Meyer, G. W.
Miller, William P.
Miller, George E.
Moore, A. H.
Monroe, Donald.
Murphy, James.

McArdle, T. F.
McCaw, A. B.
McDonald, J. W.
McLellan & Co.
McNeely, E.
McSorley, T.

Nealon, J. C.
Norman, L. F.
Noyes, William.

Pacific Gypsum and Fertilizer Company.
Paris, O. M.
Paul, Almarin B.
Perine, W. D.
Peterson, Gus.
Pierce, Owen.
Pierce, E. A.
Plant, J. H.
Price, Arthur.

Querolo, J.
Quimby, T. J.

Ralston, J. E.
Randol, J. B.
Rea, D. B.
Requa, D. Lee.
Reynolds, R.
Rhoads, J. C.
Rhodes, Mrs. H. H.
Rice, General John J.
Richardson, J. B.
Rider, P. W.
Rihrman, F.
Roberts, E. W.
Rogers, Mrs. D. B.
Ruark, J. F.
Ryninger, G. W.

Sayres, J. L.
Schmidt, Walter.
Sherman, Charles E.
Sheerin, Daniel.
Shortt, L. H.
Sickler, H. O.
Silver, Lowry.
Sinton, R. H.
Skean, George.
Smith, C. J.
Sonnenfeld, Samuel.
Switzer, John.

Tarwater, B. W.
Tapps, Q. C.
Taylor, Jones.
Taylor, J. M., M.D.
Thornburg, William.
Thompson, M.
Tolman, D. G. P.

Uhler, Conrad.

Walker, C. F.
Walton, A. E.
Watkins, George.
Watts, W. L.
Wenck, Mrs. F.
Whaling, William.
White, D. Morgan.
White, Allen G.
Wilson, David
Willard, Dr. E. L.
Williams, Lewis.
Wolcott, John R.
Wolleb, E.
Wrinkle, L. F. J.

Yates, Lorenzo G.
Young, R. A.

LIBRARY.

The Library of the State Mining Bureau has become most useful, owing to the acquisition, during the past year, of a great number of books, many of which were contributed by citizens of the State of California and by scientific institutions of the United States and foreign countries. Such books as have been purchased were selected with a view to their being the latest works treating upon the subjects for which the Mining Bureau was created. There has been an increase of over eight hundred volumes since the issue of the last report, making a total of over two thousand seven hundred books in the Library, besides a number of very interesting pamphlets. Many new cases have been added, and more have been ordered.

Some of the departments of the United States Government, and more particularly the Geological Survey of the United States, continue to send their various publications as they are issued.

Among other valuable books of reference, the Library possesses a complete set of "Smithsonian Reports" (most of which have been presented by the institution), also a complete set of the "Mining and Scientific Press" of San Francisco, and the "Quarterly Journal of the Geological Society of London." We are endeavoring to complete our set of "Smithsonian Contributions to Knowledge," of which we have purchased the first twenty-one volumes. We are also endeavoring to complete the sets of the reports of the various State Geological Surveys, of which we have the following:

Alabama—1875, 1876, 1877, 1878, 1879, 1880, 1886.
Arkansas—1887.
Connecticut—1837.
Florida—1887.
Illinois—Volumes 1 to 7, inclusive (volume 5 missing).
Indiana—1869 and maps, 1870, 1872 and maps, 1873, 1874, 1875, 1876, 1877, 1878.
Iowa—Volumes 1 and 2.
Kentucky—A, A—Volume 2—B, C, D, F. Reports of Progress 1882–4, 1884–6, 1886–7.
Minnesota—1872, 1875, 1876, 1878, 1879, 1880, 1881, 1882 (also one volume from 1872 to 1882 entitled Geology, volume 1), 1883, 1884, 1885, 1886.
Missouri—1853, 1854, 1873, 1874; also Industrial Report, 1877.
New Hampshire—Volume 1, 2, 3.
New Jersey—1868, 1869, 1870, 1874, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887.
New York—Natural History of New York, volume 1, parts four and six; volume 3 (with one volume of plates), volumes 4, 6, and 7.

New York—Reports of the State Geologist, 1885-86.
North Carolina—Volume 1.
Ohio—1869, 1870, 1873 (two volumes with maps), 1874 (two volumes with maps).
Ohio—1869, 1870, volume 1 (parts one and two with maps), volume 2 (parts one and two with maps), volume 3 (part one), volume 4 (part one), volume 5, volume 6.
Pennsylvania—Eighty-six volumes, including atlases.
Texas—First and second.
Wisconsin—1876-77.

NEWSPAPERS.

The following newspapers continue to be sent to the State Mining Bureau free:

Arizona Gazette, Phœnix, Arizona.
Humboldt Standard, Eureka, Humboldt County, California.
Mountain Messenger, Downieville, Sierra County, California.
Free Press, San Buenaventura, Ventura County, California.
Grass Valley Daily Union, Grass Valley, California.
Inyo Independent, Independence, Inyo County, California.
Mining Review, Chicago, Illinois.
Financial Mining Record, New York, New York.
Wood and Iron, Minneapolis, Minnesota.
The Weekly Star, San Francisco, California.
West American Scientist, San Diego, California.
Mining Industry, Denver, Colorado.
Honduras Progress, Tegucigalpa, Honduras, Central America.
Middletown Independent, Lake County, California.
Perris Valley Leader, Perris, San Diego County, California.
Weekly Visalia Delta, Visalia, Tulare County, California.
The Republican, San Francisco, California.

Accounts From October 1, 1887, to October 1, 1888.

Receipts.

Balance October 1, 1887	$23,133 21
Paid into Mining Bureau Fund	5,044 60
Appropriation July 1, 1888	30,000 00
Total	$58,177 81

Disbursements.

Rent	$3,000 00
Salary of State Mineralogist	3,000 00
Salaries Bureau employés	4,980 00
Salaries (geological field work)	11,490 00
Museum and minerals	962 10
Library	1,582 55
Postage	378 11
Traveling expenses (geological field work)	8,654 56
Laboratory	971 55
Clerical assistance	315 00
Freight and express charges	193 06
Sundries	568 70
Sundries (geological field work)	750 60
Wells, Fargo & Co.	1,984 37
	$38,530 60
Balance on hand October 1, 1888	19,647 21
	$58,177 81

JAMES W. MARSHALL,

Discoverer of gold in California, January 19, 1848.
Statue erected by the State at Coloma, El Dorado County.
The right hand holds the find; the left indicates the place of discovery.
F. MARION WELLS, Designer.

First Discovery of
Gold in California,
Jan. 19th, 1848.

SUTTER'S MILL, 1851.

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To his Excellency R. W. WATERMAN, *Governor of the State of California:*

SIR: In accordance with the Act of the Legislature entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880, I herewith transmit my report.

Very respectfully,

WM. IRELAN, JR.,
State Mineralogist.

SAN FRANCISCO, October 1, 1888.

REPORT OF THE STATE MINERALOGIST.

CALIFORNIA.

After the American occupation of California the condition of affairs here underwent a great change, which change became more marked in the happening of the gold find in the mill race at Sutter Mill, Coloma, El Dorado County, on the nineteenth day of January, 1848. Though the discovery was accidental and of an intrinsic value not to exceed $5, yet this golden kernel of forty years ago was the nucleus of $1,200,000,000 which our State has presented to the world.

Concerning the effects of that discovery on California, and, indeed, on the world, scarcely any event in history has exerted such a controlling influence on the affairs of mankind. It awakened everywhere the spirit of enterprise, started a vast emigration toward the Pacific Coast, created virgin fields for commerce, and directed the currents of trade into new channels. Upon the industrial system of our own country it engrafted a new and important pursuit, and one that, while it has attained to overshadowing proportions, has served to infuse fresh life into all others.

STATE ORGANIZED.

At an election held August 1, 1849, the people residing in California chose delegates to a Convention to be holden for the purpose of framing a Constitution for the proposed State.

These delegates convened at Monterey on the first day of September, and prepared a Constitution, which, upon being submitted to the people on the thirteenth day of November, was adopted by an almost unanimous vote. A Governor and Legislature having been chosen at the same election, the body met at San José on the fifteenth day of December, 1849, and on the twentieth Peter H. Burnett, the Governor elect, having been inaugurated, General Riley, who had governed under military rule, resigned the office to civil authority.

THE GREAT SEAL OF THE STATE.

"Adopted September 29, 1849, by the Convention which framed the Constitution of the State of California. Original cost, $1,000. Designed by Major R. S. Garnett, United States Army, who declined to present it to the Convention for its adoption, but gave Mr. Caleb Lyons, of Lyonsdale, New York, who was then Assistant Secretary of the Convention, authority to present the same, and expressed a desire that he alone should be known as its author. The seal is thus explained by its designer: 'Around the bend of the ring are represented thirty-one stars, being the number of States of which the Union will consist upon the admission of California. The foreground figure represents the Goddess Minerva, having sprung full grown from the brain of Jupiter. She is introduced as a type of the political birth of the State of California, without having gone through the probation

of a Territory. At her feet crouches a grizzly bear, feeding upon the clusters from a grapevine, emblematic of the country's peculiar characteristics. The sheaf of wheat and bunch of grapes were adopted as emblems of the agricultural and horticultural interests of the State. A miner is engaged, with his rocker and a bowl at his side, illustrating the golden wealth of the Sacramento, upon whose waters are seen shipping, typical of commercial greatness; and the snow-clad peaks of the Sierra Nevadas make up the background, while above is the Greek motto, 'Eureka' (I have found it), applying either to the principle involved in the admission of the State, or the success of the miner at work.'"

Upon resolution, offered by Hon. Myron Norton, the words "The Great Seal of the State of California," were added to the design.

California was admitted into the Sisterhood of States on the ninth day of September, 1850, as the thirty-first member, and is the largest State in the Union excepting Texas.

GEOGRAPHY.

The State lies between latitude 32° 31′ and 42° north, and between 37° 25′ and 46° 44′ west from Washington, and is bounded on the north by Oregon; on the east by Nevada along the one hundred and twentieth meridian to the thirty-ninth parallel; thence running southeasterly, following the State line of Nevada, to the Colorado River on the thirty-fifth parallel; thence southerly along the course of said river to the line of Lower California; thence westerly along said last mentioned line to the Pacific Ocean, which forms its western boundary. The extreme length of the State is seven hundred and seventy miles; maximum breadth, three hundred and thirty miles, and minimum breadth, one hundred and fifty miles; area, one hundred and fifty-six thousand five hundred and ninety-two square miles; length of coast line, including the islands off Santa Barbara Channel, is one thousand and ninety-seven geographical miles—equal to one thousand two hundred and eighty statute miles.

TOPOGRAPHY AND HYDROGRAPHY.

California is traversed by several chains of mountains, the principal of which are the Coast Range and the Sierra Nevadas, both running in a

northwesterly and a southeasterly direction, their strike corresponding with the general trend of the seacoast.

The Sierra Nevadas lie along the eastern line of the State, separating it in the northern part from Nevada, and have a length within the State lines of four hundred and fifty miles. The Coast Range runs nearly parallel to the Sierra Nevadas, along the western or coast line of the State. The latter range does not have that continuity nor elevation which are the marked features of the former, but is an irregular succession of less predominant spurs. There are various groups and spurs in other parts of the State, but of less importance. Between and among these mountains occur numerous valleys, some of which expand into wide, extended plains.

Coursing down the mountain cañons are innumerable streams, which, uniting, form large rivers, some of them navigable for an hundred miles or more. The lower slopes of the Sierra Nevadas, known as the foothills, constitute one of the best fruit and vine growing sections of the State. While the coast is indented with several bays, and some land-locked harbors, there are comparatively few lakes of large dimensions, though hundreds of lakelets are met with in the high Sierras and other parts of the State, some being very near the summit of the mountains, and having very pure waters of great depth. The chief harbors and wholly landlocked are the Humboldt, San Diego, and San Francisco Bays, the latter being the largest and most important, and upon whose waters commercial and naval transports representing the different parts of the world may be seen.

THE PRINCIPAL RIVERS.

The Klamath takes its source in Oregon, flows southwesterly through Siskiyou County, crosses the southeast corner of Del Norte County into Humboldt County, where it intersects the Trinity River, and carries the latter's waters northwesterly through Del Norte County to the Pacific Ocean.

The Sacramento River, the largest and most important in the State, rises to the west of Mount Shasta, in Siskiyou County, thence flows southerly to the thirty-eighth parallel, where it unites with the San Joaquin River, and empties into Suisun Bay, whose waters unite with those of the Bay of San Pablo, and reach the Pacific Ocean through the Bay of San Francisco.

The San Joaquin River has its source, through several tributaries, in the Sierra Nevada Mountains, and flows southwesterly to about the middle of the San Joaquin Valley, where it makes an abrupt turn to the northwest, in which direction it continues to where it unites with the Sacramento, near the latter's mouth, at Suisun Bay.

Of bays, lakes, and ponds, there are one thousand six hundred distributed throughout the State. The most picturesque of the lakes is Tahoe, which lies up among the snowcapped Sierras, six thousand two hundred and fifty feet above the level of the sea, and is about twenty miles long, twelve miles wide, and fifteen hundred feet deep. The total area of the lake does not lie within the State, as a portion east of the one hundred and twentieth parallel lies within the lines of the State of Nevada. Tahoe's waters are exceptionally pure, an analysis showing that the solid matter did not exceed three grains to the gallon. Its surplus waters are discharged into the Truckee River.

Tulare Lake, in the southwest part of Tulare County, is over thirty miles long and about twenty miles wide, but the amount of water is vari-

able—being greater in the warm spring months when it is supplied by the melting snow through the mountain streams.

Mono Lake is in Mono County, at an elevation of about seven thousand feet above sea level. It is about fourteen miles long, nine miles wide, and the waters are strongly saline and alkaline.

Klamath Lake is really one of Oregon's possessions, yet the lower part, known as Lower Klamath Lake, extends across the boundary line into Siskiyou County.

Goose Lake is largely in Modoc County, a small portion being within the line of Oregon's boundary. It is about thirty miles long and ten miles wide, and discharges its waters through Pitt River.

Owens Lake, about eighteen miles long and ten miles wide, is in Inyo County, about twelve miles easterly from Mt. Whitney. It obtains its water supply from Owens River, and like Mono is strongly saline and alkaline.

Clear Lake is in the Coast Range in Lake County. Its extreme length is about twenty-five miles; extreme width, ten miles, and a minimum width about two miles, which is near the middle, being a little strait connecting the upper and lower lakes. The water is very deep and extremely pure.

There are quite a number of other lakes with variable amounts and conditions of waters, but the above mentioned comprise the most important.

POPULATION AND PROPERTY VALUES.

The population exceeds one and one half million souls, over one hundred thousand being Chinamen. The number of inhabitants has of late increased very rapidly, this increment having occurred during the past six years.

The assessed value of the property in the State, as shown by the County Assessors, for 1888, amounts to $1,063,863,675, being an increase of $108,417,836 over the valuation of the preceding year. The valuation of the railroad property, amounting to $43,242,652, is not included in the above figures, as it is assessed separately by the Board of Equalization.

VALUE OF MINERAL PRODUCTS TO DATE.

According to authoritative statements, the value of the bullion produced in California amounts, up to this time, to a total of $1,210,000,000. Of this sum, $1,174,000,000 have consisted of gold and $36,000,000 of silver.

Of the more important useful minerals, there have been produced, meantime, values approximating as follows: Quicksilver, $60,000,000; borax, $5,000,000; salt, $4,000,000.

Our deposits of coal, copper, lead, petroleum, and asphaltum, building stones, and plastic clays have all been worked on a large scale, and generally with remunerative results; while the working of our deposits of antimony, chromic iron, and gypsum have ranked among the subordinate but always paying industries of the State.

Deposits of iron, graphite, sulphur, manganese, asbestos, soda, nitre, and, in short, almost every mineral substance found in nature, occur in California; and although none of these have as yet been much utilized, enough is known to indicate for the most of them a large prospective value.

Extending for nearly four hundred miles along the westerly foothills of the Sierra Nevadas occur the main gold fields of the State, having an average width of thirty-five miles. Another, but smaller, gold field occupies

the northwest angle of the State. It stretches across the northern portion of the Coast Range, which, here spreading out into several parallel ridges and detached groups of mountains, covers a wide expanse of country.

There are other gold-bearing localities in different parts of the State, some of which possess auriferous resources of no mean order. Most of the silver produced in California has come from Mono, Inyo, and San Bernardino Counties—principally from the latter—while Alpine and Shasta, and several other counties, have produced small quantities.

THE MINING BUREAU.

The Mining Bureau is now satisfying a want which the State has been sadly in need of since the commencement of quartz or ledge mining. It is gathering the records of the earliest mining ventures, collecting statistics of present developments, the methods of recovery of the precious metals, examining the unexplored mineral sections, and determining the lithological structure of the inclosing rocks. It is making known to the world the mineral resources of the State. Through its agency much capital has come here from abroad; letters of inquiry from foreign countries, as well as from our own, are daily received; the nature of minerals and soils are daily determined. The prospector has been advised and encouraged, new fields for development have been made known to our people, and it has been the means of unearthing minerals heretofore unknown to exist in the State. It has advised the ore worker of the best methods to manipulate the ores in order to procure the largest returns at the lowest possible cost; and furthermore, it is carrying out the cause for which the old Geological Survey was created, and which, had it been properly supported, would have been of incalculable benefit to the State.

Our people have been in almost geological ignorance, squandering money and wasting energy through the want of system and knowledge.

The most necessary adjunct to successful mining is machinery. Many of the mines now idle could be reopened and placed upon a paying basis, providing machinery suitable to the peculiar character of the ores could be procured; likewise many of the lower grade ores could be made to pay a profit, if encouragement were only extended to the toilers in that direction. It is unquestionably the fact that the want of knowledge and of the proper machinery is the cause of much of our mineral property now lying dormant.

The various necessary tests cannot be made in a day, a week, or a month, but will in many cases require a series of experiments extending over a long time, and in conjunction with science.

When the correct methods of working the ores successfully and profitably are elucidated, then the process can be cheapened and the machinery be procured suitable to make the recovery larger than the outlay.

There should be a comprehensive record of the mining industry on hand, that a ready reference might be made to the output of the precious and economic minerals. Not only should we have a record of the mines now in operation, but also of those which have already contributed their wealth to the world. The latter serves as a reference of the State's past record, and furnishes a foundation upon which to build future expectations.

The inclosing rocks are of the greatest importance to miners, and since it has been demonstrated that their nature is an indicator of that which may be uncovered deeper down, the mining industry has received an impetus that is likely to open a new era and add largely to our production of the precious metals.

Geology teaches us of the formation of the constituent parts comprising the earth and the relation they bear to each other. It is a science that every one should be more or less acquainted with, the tiller of the soil as well as he who seeks the treasures hidden beneath the earth's surface. With a knowledge of the geological construction, we are enabled to form an opinion as to the location best adapted to our vocation, be we farmers, miners, viticulturists, or growers of fruit.

It is for these reasons that the Mining Bureau has decided upon taking up the work where the old Geological Survey left off, and completing the geological map of the State.

Theories are worthless without practical confirmation. The past history of the State is replete with theoretical failures. Our people have paid dearly to locate mineral veins upon such principles. Machinery has been constructed upon such empirical formula, and vast fortunes have been swept away in seductive illusions. Small is the number of our mine owners who have not had an expensive experience with these theoretical visions. Read any of the mining news of the day and it will often be observed that large sums of money are now being theoretically wasted, which proves beyond question that it is practical work, in conjunction with scientific application, of which we are so much in need. The science of geology, practically applied, has been an acknowledged boon to other States and countries, then why should it not prove so to California?

It is not to be expected that those who toil in the large majority for a daily sustenance should be conversant with scientific research; nor should any such lack of knowledge call up the question of reproach. It is simply that the greater number of those who have been fortunate in obtaining scientific acquirements have done so through financial support.

Metallurgy is a fair similitude wherein it is readily observed that the smelter of ores who is alone practical is in a large majority of cases not a success; likewise he who depends solely upon his scientific attainments stands on an equal footing. But he who is possessed of both fundamental principles, practice and science, is in effect a success. One who is capable of performing an analytical segregation and cognizant of those elements which have the greatest affinity for each other is one to whom, in metallurgy, failure seldom occurs. Cases have occurred in our own State, and of not a very remote date, where persons taught by a practical scientist could work the smelter equally successful as their teacher, but when placed in charge of furnaces in other sections than those in which they had learned, a failure was the result, and on account of the ores being of a different composition.

If these practical smelters had been students of sciences, as applied to metallurgy, they could readily have obviated the difficulty by a knowledge of chemical affinity.

It is not to be understood that the object of this article is written for the purpose of disparaging the ability of the practical worker, for were it not for the assistance given through his experience, science would avail but little. In fact there is as much honor due the practical man as to him of sciences, but it is beyond question that it requires the unity of the two abilities for a pronounced success in geological, mineralogical, and metallurgical research.

In proof of the advantages of mechanical ingenuity scientifically applied one has but to take into consideration the amount of low grade ores now being worked to a profitable advantage. So far as the actual development of our mineral resources is concerned, all honor is due the practical worker, but that he cannot solve the mineralogical and metallurgical enigma we have practical proofs.

The ores that are now producing a profitable recovery, a few years back would have been a losing venture. As an instance of proof of the statement, a citation of what scientific research has done for the benefit of a mine in Amador County is convincing: The assay value of the ore does not exceed $4 per ton—$1 50 of which is free milling, the remaining value combined with the sulphurets. The company levied continual assessments, until the present manager was put in charge of the property, and through his skill and ability the mine is now remunerative; and such remarks can be truthfully made of other similar undertakings.

The low grade ores are no longer despised, and the long condemned tail piles are being reworked.

Europe has acknowledged the lessening of the risk of mining ventures since the various governments have found the limits of their mineral belts through the aid of scientific field work.

California, the largest State in the Union, excepting Texas, with a record of having produced more precious metals from the same area than any other piece of land in the world; a State within whose confines all of the known metals and many species of the precious stones are found; a tract of land which, if fenced in with an impenetrable and insurmountable wall, that there should be neither ingress nor egress, and then be capable of supporting many times more than the present number of its inhabitants on its own productions, does not know its own geological formation, has no reliable statistics of its mineral production, and is unpardonably ignorant of its capabilities. Other States in the Union have appropriated largely for geological investigations, and have been manifoldly rewarded for the expense. Such judicious expenditures increase the wealth of the State, and thereby enlarge the incomes of its inhabitants.

The solidity that has characterized California's greatness is undoubtedly due to the golden output that for four decades has annually added to the world's wealth.

To show the high opinion in which the Mining Bureau is held, the citizens of other States where mining exists are agitating the importance of the establishment of a Mining Bureau on the same basis as ours. The citizens of Colorado are now circulating a petition, to be presented to their next Legislature, for the purpose of creating a similar institution with the same laws and forms of government, and have corresponded with us upon the subject.

The importance of the work being done by the State Mining Bureau has exerted its influence in the Republic of Honduras, Central America, as will be seen by the following extracts, taken from the "Honduras Progress," dated at Tegucigalpa, April 26, 1888:

"HONDURAS GOVERNMENT MINING BUREAU.

"The increasing importance of the mining industry of Honduras is clearly manifested by its augmented bullion output of precious metals, as well as by the constant arrival of new mining parties from abroad, and the daily discoveries of rich ore bodies, of which Honduras abounds, both on its Pacific and Atlantic slopes.

"Centuries ago, when the mineral fields of Honduras were in possession of Spain, the world was amazed with the treasures of gold and silver derived from this country. Centuries have gone by and were it not for the great number of old Spanish mines and works left to us, and for the many and rich lodes and deposits of valuable minerals, which are found in most of the mountains, we might doubt the veracity of the *old records* which are preserved as *official* documents in the government archives at Tegucigalpa.

"We have now the mighty science in its many forms to help us, that has made tools and machines, which, when compared with the implements of the ancient Spanish miners, will contrast most favorably. Dynamite, steam, and electricity are now used on the same lodes where centuries ago fire, iron, and slave labor were employed.

"The improved methods of mining and milling have given us means to reopen many of the old mines, which, it was thought, were lost forever. The fact that there are in Honduras rich bodies of precious and economic metals is now reëstablished beyond all doubt, and though the modern mining industry of this country is yet in its infancy, Honduras, even at this time, possesses mines which rival with the best of properties of any mineral district outside of this country.

"General Don Louis Bogran, President of Honduras, desirous to bring the mining interests of this Central American section prominently to the front, has granted the most liberal mining laws and given valuable concessions to foreign pioneer companies, that came here to develop our vast mineral resources.

"The necessity of establishing a government office, the purpose of which shall be to further the mining interests of Honduras, has been felt for some time. For this reason, President Bogran has decreed the establishment of a Mining Bureau, on similar basis as those existing in the State of California, and in most parts of Europe. Dr. R. Fritzgartner, Inspector-General of mines, who is now connected for a number of years with the mineral development of this country, will be in charge of the office. The principal feature of the work of the Mining Bureau will consist in the examination of ores and minerals for their economic and scientific value. A certain amount of field work and exploration is to be carried on, as fast as time and means will allow it. There will be at this capital geological and mineralogical collections of the Territory kept on public exhibition for study and reference. Maps and drawings of the principal lodes and mines will be kept in the Mining Bureau, to illustrate the practical development of the ore bodies of this country. It is further intended to publish annual reports, relating to the progress of our mining industry, with communications of a scientific character, such as description of geological groups and minerals occurring in Honduras.

"Parties interested in mining enterprises in Honduras, who live abroad, may address the officer in charge of the Government Mining Bureau for any information required pertaining to the general development of Honduras. It is to be hoped that our mining men will take a sufficient interest to forward samples of ores, wall rocks, and geological specimens to the Mining Bureau, where a list of specimens and names of donors will be kept on file.

"Foreign societies, firms, and institutions, which pertain to science and practical pursuits, are requested to favor the Honduras Government Mining Bureau with their publications and duplicate specimens of minerals, rocks, and fossils, which will be thankfully received, and the necessary exchanges made with pleasure and promptitude."

The establishment of a State Museum was advocated as early as 1862, as will be seen from the following extracts from a letter written by Professor J. D. Whitney, State Geologist, to Hon. Leland Stanford, then Governor of the State.

After making mention of the topography, physical geography, etc., Professor Whitney further writes: "If the necessary amount of money can be raised to carry out these plans, California will in a few years be possessed of a State Museum which will be of the highest value as a means of education, and will be the depository of specimens of all that is scientifically interesting or economically valuable on the Pacific Coast. Owing to the peculiar condition of the country at present, I am not disposed to press this matter, but the importance of securing our valuable collection from loss by fire, and of placing them where they will be available, will make it necessary that the consideration of this subject should not be deferred more than a year or two, at the outside."

It is but eight years since the Hon. George C. Perkins, Governor of the State, affixed his signature to the Act, passed by the Legislature, for the creation of a State Mining Bureau, yet in that short space of time California has become possessed of a Museum second to no other similar institution in the world, and the collection is daily studied by our people.

Gathering, arranging, and harmonizing has been a task attended with many difficulties—especially in relation to veins and their metallic contents.

The field work was commenced on the first day of April and discontinued on the fifteenth day of September, since which time the information collected has been written up. A recapitulation has been attached to the description of each mine, but it has been the endeavor to avoid, as far as possible, tautology in the general descriptive matter. However, when it is taken into consideration the shortness of the time in which the field notes were prepared for press, any small, unimportant incongruities should be overlooked.

The Trustees give almost daily attention to the affairs of the institution, and to their unremitting zeal is largely due the position which the Bureau holds among other similar establishments of the world.

To Mr. J. Z. Davis, Chairman of the Board of Trustees of the State Mining Bureau, for his ardent and active interest, and generous gifts, we are especially indebted.

Contributors of papers on special subjects are given under the names of the respective writers.

We wish to acknowledge our obligations to those who have so kindly and courteously received and imparted information to the attachés of the Bureau.

The following list comprises the names of the field assistants: W. L. Watts, J. H. Crossman, Samuel Locke, W. A. Goodyear, F. F. Thomas, C. H. Aaron, Lowry Silver, A. McGregor, E. C. Van Blarcom, H. A. Whiting, T. J. Quimby, A. Blanc, Dr. Stephen Bowers, Melville Attwood, Dr. W. D. Johnston, J. F. O'Gorman, C. A. Ogden.

The list of questions used for the desired information is hereby appended, but were in a number of cases unanswered—sometimes from inability and at others for private reasons:

Name of county.
Name of mine.
When located.
Mining district.
Name of nearest town.
Direction and distance from town.
Vein—
  Course.
  Direction of dip.

Degrees of dip.
Average width.
Dimensions of claim.
Length of ore shoot.
Tunnel or shaft.
Length of tunnel.
Vertical depth from surface reached in tunnel.
Shaft—
Vertical or incline.
Depth on incline, feet.
Vertical depth reached, feet.
Formation of walls—
Hanging.
Foot.
Quantity of water coming in.
Kind of pump used.
Name of compressor used.
Kind of powder used.
Quantity of powder used, in pounds.
Quantity of steel used for drills.
Cost of mining per ton of ore.
Cost per foot in running tunnel.
Number of feet run per day.
Cost per foot in sinking shaft.
Number of feet sunk per day.
Formation passed through.
Length of tunnel or shaft timbered.
Kind of timber used.
Cost of timber.
Distance from mine to timber.
Length of road built by the company.
Length of ditch built by the company.
Means of transporting ore to works.
Cost of transporting ore to works.
Character of ore.
Method of treating ore.
Description of mill or works.
Stamps—
Number of.
Weight of.
Drop in inches.
Drops per minute.
Duty per stamp—tons crushed in twenty-four hours.
Kind of metal used for shoes and dies.
Cost of shoes and dies per pound.
Wear of shoes and dies per ton crushed.
Quantity of water used in battery.
Battery screens—
Wire.
Punched.
Round punched.
Slot punched.
Size or number.
Dimensions (inside of frame).
Vertical or inclined.
Plates—
Size of apron.
Width of, in sluice.
Length of, in sluice to each battery.
Size of inside of battery.
Copper or silvered.
Inclination, —— inches to the foot.
Kind of feeders used.
Pans—
Number.
Kind.
Wear of shoes and dies, per ton of ore worked.
Chemicals used in pans.
Salt used in pans, per ton.
Water used in pans, per ton of ore.
Water used in settlers, per ton of ore.
Percentage of salt used in roasting ores.
Percentage of value saved—
In battery.
On plates.

In pans.
On concentrators.
Loss of quicksilver, per ton of ore worked.
Name of concentrators used.
Number of concentrators.
Quantity of water used on concentrator.
Sulphurets—
Percentage of.
Nature of.
Value of, per ton.
In gold.
In silver.
Method of saving.
Method of treating.
Cost of treating, per ton.
Percentage of value saved in working.
Roasting furnaces—
Description of.
Number of.
Capacity of, tons in twenty-four hours.
Consumption of fuel, per ton of ore.
Percentage of silver chloridized.
Number of men—
In mine.
In mill.
Outside work.
Total.
Average wages paid per day—
In mine.
In mill.
Outside work.
Cords of wood used per day—
For steam.
For drying ore.
For roasting ore.
Cost of wood, per cord.
Species of wood used.
Water or steam power.
(State kind and size of engines or water motors; also, if water motors, quantity of water used in each, and height of fall. Give measure of water in cubic feet, if possible; if in miner's inches, give manner of measurement.)
Cost of water.
Developments.
Developments made during the year.
Proposed improvements.

MINERAL RESOURCES OF THE STATE.

CONSIDERED BY COUNTIES.

In treating this branch of our subject, the several counties of the State have been taken up in alphabetical order, as being an arrangement tending best to promote convenience of reference.

Originally there were in California but twenty-seven counties; there are now fifty-two. Klamath, one of the original counties, has been extinguished, and the territory of which it was composed annexed to Siskiyou and Humboldt. The term Branciforte, applied to one of the primitive counties, was afterward changed to Santa Cruz, the name this county now bears.

COUNTY NAMES.

While the derivation and meaning of the names given to these fifty-two counties will, so far as required, be explained in the proper place, it may, as a means of obviating needless repetition, be here stated that the term

San or Santa, where it occurs as a prefix, shows the county to have been named after some canonized personage in the Roman Catholic calendar. In like manner, other of these names, such as Sacramento, Trinity, Santa Cruz, etc., commemorate some of the institutions, or represent certain of the emblems of that church. Twelve counties have been thus named. Though only one of the native Californian families has been honored by having a county called after them, this distinction has been conferred on three of the early American settlers in the country.

While most of our county names have been selected with due regard to propriety and good taste, it must be conceded that the appellations bestowed on many localities in California, have been in violation of the rules of both esthetics and fitness, this remark being especially applicable to some of the early mining camps.

Looking over the map of California the extremely irregular contour of most of the counties is noticeable.

There is not a single square county in the State, and but one that is rectangular in form, the same being true of the adjoining State of Nevada. It will be observed that many of these counties are greatly out of proportion as regards length and breadth, being long and narrow as well as of curious outline. These peculiarities are due to the topography and river system of the country, especially in the foothill region of the Sierra Nevadas. The westerly slope of these mountains is eroded by numerous deep and crooked cañons, separated from each other by high ridges or divides. In laying out the counties, it was, as a general thing, found expedient to confine a single county to one of these divides, making the rivers that flow through these cañons their lateral boundaries. In other cases rivers, mountain ranges, and the seashore largely determined the shape of the counties, hence these irregularities and disproportions that distinguish the map of California from that of the older States, more particularly those occupying the prairie lands of the middle west, where it was practicable to lay out the counties with the regularity of a checker-board. That some of them are large while others are comparatively small is another feature of these California counties, due to the peculiar conditions they obtained when they were organized; while in the fertile and populous districts the counties were restricted to a comparatively small area, in the sparsely peopled desert and mountainous regions they were made to include a large extent of territory, much larger, in several instances, than some of the sovereign States of the Union; thus, San Bernardino County is more than twenty-five times larger than the State of Rhode Island, more than fifteen times larger than Delaware, and nearly three times larger than Connecticut. There are in California thirty-nine counties each larger than Rhode Island, thirty-two larger than Delaware, and sixteen larger than Connecticut. San Bernardino County contains over twenty-one thousand square miles, there being several other counties in this State that contain from five thousand to fourteen thousand square miles each.

In generalizing further, it may be observed that the gold mines of California occur at altitudes varying from two to three hundred feet to five or six hundred feet above the sea level—the main auriferous belt lying between the heights of one and three thousand feet.

As regards climate, the wet and dry seasons prevail in the mining regions as elsewhere throughout the State, the wet season being longer, and the rainfall greater at the north, whence they diminish gradually toward the south. The amount of precipitation increases also with altitude.

This much of prefatory remarks has seemed necessary to a proper explanation of the many features, including some striking peculiarities, common to the counties of California.

ASSESSED VALUE OF THE STATE BY COUNTIES.

Counties.	1887.	1888.
Alameda	$60,589,770	$66,918,510
Alpine	288,435	275,869
Amador	4,320,066	4,412,720
Butte	17,193,275	20,297,937
Calaveras	4,198,139	4,224,070
Colusa	22,893,269	24,716,718
Contra Costa	15,134,277	15,934,050
Del Norte	1,471,315	1,871,560
El Dorado	3,424,907	3,707,924
Fresno	18,723,847	34,876,809
Humboldt	12,731,962	17,756,801
Inyo	1,399,872	1,518,677
Kern	8,857,331	11,110,516
Lake	2,992,858	3,682,931
Lassen	2,384,541	2,553,155
Los Angeles	99,416,402	102,944,061
Marin	10,416,674	10,981,946
Mariposa	1,624,866	1,875,395
Mendocino	10,404,962	11,288,355
Merced	11,726,853	14,917,870
Modoc	2,863,178	3,078,598
Mono	1,183,734	987,444
Monterey	14,582,544	15,442,857
Napa	13,350,807	14,437,355
Nevada	6,329,519	6,367,333
Placer	9,380,373	10,098,294
Plumas	2,255,044	2,320,578
Sacramento	28,303,295	33,897,435
San Benito	5,589,131	6,265,503
San Bernardino	20,441,690	26,500,680
San Diego	22,862,250	41,522,608
San Francisco	251,917,659	273,539,826
San Joaquin	33,497,636	38,689,149
San Luis Obispo	11,787,416	14,662,763
San Mateo	10,400,686	13,702,825
Santa Barbara	15,159,059	20,003,387
Santa Clara	43,483,031	53,031,413
Santa Cruz	8,707,156	10,704,389
Shasta	5,709,291	6,512,431
Sierra	1,830,348	1,744,569
Siskiyou	5,747,423	6,776,354
Solano	19,026,009	19,905,188
Sonoma	27,500,264	30,121,898
Stanislaus	15,296,884	15,580,071
Sutter	7,850,523	10,033,866
Tehama	10,552,455	11,908,345
Trinity	1,092,832	1,149,664
Tulare	15,224,012	24,286,023
Tuolumne	2,534,406	2,572,899
Ventura	6,595,420	8,855,251
Yolo	17,927,167	20,462,264
Yuba	6,617,070	7,017,753
Totals	$955,796,933	$1,108,044,877

ALAMEDA COUNTY.

This county derives its name from the Spanish term "alemeda," signifying a "grove of poplars," many trees of this kind having by the original settlers been here found growing along the streams. Alameda is bounded on the north by Contra Costa, on the east by San Joaquin, on the south by Santa Clara County and the Bay of San Francisco, and on the west by the Bay of San Francisco.

As regards surface elevations Alameda is about equally divided between mountains, hills, plains, and valleys; the Contra Costa range of mountains trending northwest and southeast, strikes centrally across the county, a broad and fertile plain lying between the western foothills of this range and the Bay of San Francisco; skirting the bay is a large area of tule and overflowed lands, these being the site of the extensive salt works elsewhere remarked upon. In the Contra Costa Mountains occur many rich valleys, through which course small creeks; these with some sloughs making up into the tide lands constitute the entire water system of Alameda, there being no river or large streams in the county.

Alameda is without timber other than some scattered oaks on the plains, a few sycamores and cottonwoods along the creeks, and a sparse growth of scrub oak and pine on the mountains; these cottonwoods being the so called poplars of the Spaniards.

To compensate for her paucity of timber and water, Alameda possesses a rich soil and an admirable climate, with superior facilities for transportation. Throughout nearly her entire length she abuts on the Bay of San Francisco, from which extend islands, a number of navigable inlets and sloughs, while not less than half a dozen different railroads traverse the county in various directions. Her mineral resources, noticed further on, without being large are very considerable, additional value being imparted to this class of products through the cheapness with which they can be transported to market.

PETROLEUM.

The petroleum interests of Alameda County are at present at a standstill, but it is the intention of those concerned in the enterprise to resume operations as soon as suitable arrangements can be made. Petroleum was first discovered in Alameda County on the ranch of Joshua Brown, in S. 26, T. 2 S., R. 2 E., M. D. M., about four miles east from the town of Livermore. At the time of the earthquake in 1868, a subterranean explosion occurred, which displaced large masses of the conglomerate and coarse sandstone formation on this ranch, the rocks being in some places blackened as though large charges of blasting powder had been used. Simultaneously a spring of water commenced to flow about seventy-five yards from the point of disturbance, the waters containing traces of petroleum, and considerable gas rising therefrom. This incident suggested the idea of prospecting for oil and gas, and a drill hole ten feet deep was sunk in the spring. This caused a viscous black oil of the consistency of tar to flow in such quantities that a five-gallon can could easily be filled in two hours. Prospecting was recommenced in 1875, and a well fifty-nine feet deep was bored. Water and petroleum were struck at a depth of forty-five feet, and continued to flow until the hole (which was not cased) caved in. In 1886, a company, under the name of the Alameda Oil and Gas Company, bored a hole a few yards north of the first prospect, and at a depth of about one hundred and sixty-five feet obtained a stream of water and

some oil; the well was bored to a depth of two hundred and eight feet, but no increase of either water or oil was recorded. This well still affords a small stream of water, upon the surface of which a little petroleum collects, and inflammable gas is given off in bubbles.

STRATA MET IN BORING.

Soil	5 feet.
Sand rock	160 feet.
Strata of pebbles as large as peas	43 feet.
Sand rock at finish.	
	208 feet.

Immediately above the spring which was opened by the earthquake in 1868, the sand rock can be exposed by shoveling. It dips to the southwest at an angle of about 30 degrees, and is overlaid by a stratum of clay containing carbonaceous matter. The rocks cropping out from the summit of the hills overlooking the spring are conglomerate and coarse sandstone, the formation being so displaced as to destroy all appearance of stratification. A boring was made by the Livermore Oil Company, about eight miles east of Livermore, in the direction of Corral Hollow, to a depth of about three hundred and fifty feet. Prospecting for oil was commenced in this neighborhood several years ago, oil having been observed upon the surface of a spring a few yards southwest from the boring of the Livermore Oil Company. Sandstone and shale upon the west bank of this spring are impregnated with oil. Oil was also discovered at an early day in the Palomares Cañon near Haywards. A small shaft twenty feet deep was sunk in a spring, six miles northeast of that town; salt water and a dark colored oil raised nearly to the top of the well, both of which disappeared after the earthquake of 1868.

COAL

The only recent developments in the coal measures of Alameda County are in the eastern extremity of the Livermore Valley, upon the west side of the dividing ridge, between it and Corral Hollow. Coal was first prospected for at this point about thirteen years ago, the locality being then known as Harrisville.

THE LIVERMORE COAL COMPANY.

This company was organized in 1875, and discontinued after eighteen months' run. The works of this company are situated at the west end of the ravine in which the Livermore Valley terminates, towards the east. The bunkers, tramway, and shaft house are all standing. These works are said to be four hundred feet deep, but are now filled with water to within one hundred feet of the surface. The formation dips at an angle of 35 degrees.

PENDARIN COAL MINE.

This mine, about six or seven hundred yards further up the ravine, was opened by Jenkin Richards, and subsequently bonded by D. Gutman, of Livermore, who, in February, 1888, organized the Livermore Coal Mining Company.

THE LIVERMORE COAL MINING COMPANY.

The land now held by this company is one hundred and sixty acres, being the southwest ¼ of Sec. 26, T. 3 S., R. 3 E., M. D. M. Work was com-

menced on this property in 1882, by running tunnel No. 1 and incline No. 2 (see diagram).

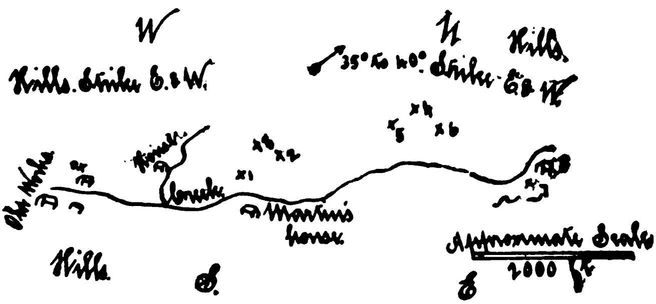


DIAGRAM OF EASTERN EXTREMITY OF LIVERMORE VALLEY, ABOUT EIGHT MILES FROM LIVERMORE.

Penadrin Mine.

0. Old works of Livermore Coal Company.
1. Tunnel commenced by Richards, and continued by Gutman.
2. Incline opened by Richards.
3. Inclined shaft opened by Gutman.
4. Long tunnel opened by Richards.
5. Blacksmith's forge.
6. Incline opened by Richards.
7. Coleman Tunnel.
8. House on Coleman claim.

At both these openings, and also at an incline shaft No. 3 further up the side of the ravine, the strata dip to the north at an angle of 30 degrees to 35 degrees. The tunnel No. 1 runs in a northerly direction, and is about one hundred and twenty-six feet in length, and as will be seen by referring to the table below, penetrated strata of clay and sand; coal was reached after tunneling a distance of about ninety-four feet; this seam was only a few inches wide, and mixed with clay and shale. A stratum of clay containing seams of gypsum was then encountered; this hardened somewhat as it approached, and formed a footwall to a second vein of coal. This vein was a little over two and a half feet wide, but broken and mixed with shale and gypsum.

TABLE

Showing Character of Strata passed through in the Lower Tunnel, Pendarin Mine, and their Approximate Thickness.

Character of Strata.	Approximate Thickness, in Feet.
Sand, interlaced with sandy shale	90
Sand	
Thin stratum of clay	
Clay containing gypsum	4
Hard stratum	
White sand	
Clay and coal (4 inches)	
Clay containing more coal (6 to 18 inches)	1½
Clay shale containing seams of gypsum	28
Coal (30 inches)	2½
Headwall (white sandstone)	126

Thinking that the vein would consolidate as it went deeper, the inclined shaft, No. 3, was opened in 1887, a short distance higher up the side of the

ravine. After sinking one hundred and ten feet, forty feet being directly on the vein, the formation became more solid, and perseverance was rewarded with a vein of good coal over two feet wide. This vein likewise dips towards the north at an angle of 35 degrees. The lower incline, No. 2, which is not much more than one hundred feet northeast of the tunnel, No. 1, is sunk directly on the vein. Within a few feet of the commencement there is a fault of about five feet, and for some twenty-five feet the vein pinches out. This working is now partially filled with water. It is stated that the vein at the bottom is four and a half feet wide. About two thousand feet higher up, upon the same side of the ravine towards northeast, is another working, No. 4, also on the land held by the Livermore Coal Company. This consists of a tunnel running in about three hundred and twenty feet. Here the strata dips to a trifle west of north and at an angle of 40 degrees. This is probably the same vein that was worked on the Coleman property, upon the opposite and southeast side of the ravine; it is, however, reached by cutting through the underlying, instead of the superimposed strata, the latter being the case in the Coleman Mine. The strata passed through differ somewhat from those at the lower level, as will be seen by referring to the table below, or to the specimens in the Museum of the State Mining Bureau.

TABLE

Showing Character of Strata passed through in the Upper Tunnel, on the Property held by the Livermore Coal Company.

Character of Strata.	Approximate Thickness, in Feet.
Sandy clay	70
Three feet white sand	3
Clay shale (horse)	4½
White sand	4
Clay	12
Sand	1
Clay	6½
Sand and clay	12
Sand-clay with a little sand	10
Sand and clay	60
Sand stained with iron	40
Clay streaked with iron and intercalated with sand	12
Sand and clay passing into sand	20
Clay, at times sandy, which hardened into a shale as it approached and formed footwall to coal vein	64
Coal vein	2½
Headwall, brown sandy clay, and shale.	
Total	321½

A notable feature of this series is the forty feet of white sandstone, streaked with oxide of iron, from which water was exuding in some places along the iron-stained bands. The vein of coal at the end of the tunnel appears to be more compact than at the lower working; it lies between a footwall of clay shale and a headwall of brown sand rock.

THE COLEMAN MINE.

This property, No. 7 in the diagram, is situated about fifteen hundred feet a little east of north from the upper tunnel on the property of the Livermore Coal Company, and covers an area of two thousand eight hundred acres. Considerable work has been done on this claim, but it has lain idle for several years. A tunnel here penetrates the formation in an

opposite direction to those already described. At a distance of about three hundred and twenty feet from the mouth this tunnel has been crosscut, an incline running east upon the vein in one direction, and a winze being sunk, also upon the vein, a short distance to the west. These workings are caved in many places, and are in a dangerous condition. More work has evidently been done upon this mine, but the first portion of the tunnel, from its mouth to the coal vein, and thence down the incline to the east, was alone in a condition to render exploration compatible with safety. The formation upon this side of the valley is very much more disturbed than upon the west, in many places so much so as to render the dip of the measures difficult to determine. The coal vein, which is about five feet wide at the bottom of the incline, above mentioned, dips a little west of north, at an angle of 70 degrees. Reference to the following table will show the character and approximate thickness of strata penetrated between the mouth of the tunnel and the vein. A prominent feature of this formation is the occurrence of strata of clay and shells.

TABLE

Showing Character of Strata passed through between the Mouth of Tunnel and Vein in the Coleman Mine.

Character of Strata.	Approximate Thickness, in Feet.
Fine sand rock	3
Coarse sand rock	8
Clay	28
Sand rock	22
Clay	3
Sand	10
Clay	10
Sand	7
Calcareous clay (containing broken shells)	10
Clay	10
Fine sand	20
Coarse sand	66
Clay	4
Sand	3
Clay	34
Coarse sand	36
Clay and gypsum	8
Sand with streaks and pockets of clay	20
Sandy clay (containing broken shells)	4
Clay shale (brown, sandy)	16
Coal	5
Foot wall, clay shale.	
Total	327

Analysis of coal from the Livermore Valley, made by Professor Thos. Price for the Livermore Coal Mining Company:

Number 1.

Water	18.08
Volatile carbonaceous matter	39.30
Fixed carbon	35.61
Ash	7.01
Total	100.00

Number 2.

Water	20.78
Volatile carbonaceous matter	31.00
Fixed carbon	42.46
Ash	5.70
Total	99.94

On the east side of the divide at Corral Hollow, the Eureka, Alameda, and Pacific Coal Mines are situated, but they have long been shut down.

COAL NEAR HAYWARDS.

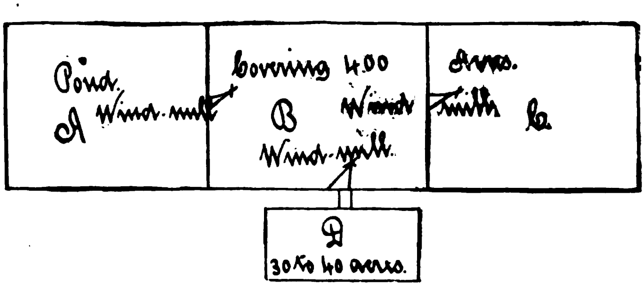
Several years ago coal was prospected for in the vicinity of Haywards, but the veins were too small to warrant a prosecution of the industry. Upon the ranch of W. Haywards, one and one fourth miles east of the town, a shaft of over two hundred feet was sunk; also upon the Heller ranch, two and one half miles east of Haywards, a shaft was put down to about the same depth, and a drift run of some one hundred and fifty feet. A small quantity of coal was taken out, but operations were stopped by water.

SALT.

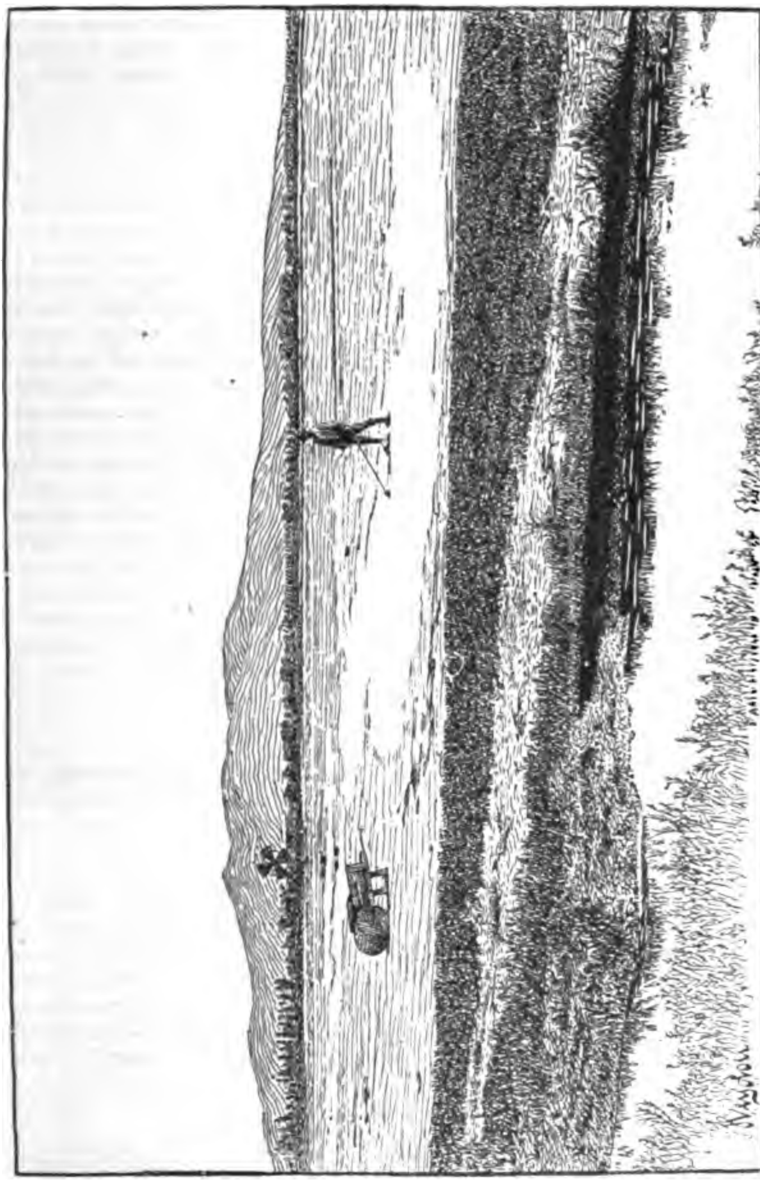
Probably the most important mineral industry of Alameda County is the recovery of salt from the waters of San Francisco Bay. This business is carried on extensively upon the east shore of the bay, in the neighborhood of Alvarado and Mount Eden. At the former place Messrs. Plummer, Barton, Quigley, and others have their works; at Mount Eden are the works of P. Marsicano and the Union Pacific. At present some of the works are shut down (it is stated by the salt trust, to avoid an over-production). Two methods are employed in Alameda County for the recovery of salt from sea water. One is by complete natural evaporation and gathering the residue; the other by allowing tanks of sea water to evaporate until a saturated solution is obtained, from which the salt is recovered as it crystallizes.

THE QUIGLEY SALT WORKS.

The first process is at use in the salt ponds of the Messrs. Quigley, of Alvarado. At these works a pond covering four hundred acres, and surrounded by a levee, is filled with sea water at spring tide. This pond is divided into tanks, such as A, B, C, as shown in the diagram, and as the density of the water in the tanks increases by evaporation, it is pumped by windmills from tanks A and C into B, until tank B is filled with strong brine. This brine is pumped into reservoir D, which is filled to a depth of twelve or thirteen inches.



Here the density of the liquid rapidly increases, and the salt commences to crystallize. When a crust one and a half inches in thickness has formed upon the floor of the pond, the salt is scraped up. After gathering the salt, whatever mother liquor (bittern) remains is run off, no effort being made to recover any of the elements it may contain. The best and whitest salt is obtained in warm, windy weather, the wind forming ripples in the



SALT POND, ALVARADO.

solution, which wash the rapidly forming crystals. In still, hot weather, the salt has a yellow tinge. It takes about three years for a pond to get into a suitable condition for the production of salt. In that time a peculiar "skin" grows over the bottom, this protecting the solution from contamination by earthy matter. These works have been running for twenty years. Their output has been from two thousand five hundred to three thousand tons per annum. The price obtained has varied from $9 to $20 per ton. The second process is in use at the California and Union Pacific Salt Works, in the vicinity of Mount Eden.

THE CALIFORNIA SALT WORKS.

The works of this company are situated about half a mile southwest from the Mount Eden railroad depot. The plant consists of fifty salt ponds, which are arranged in "schools" (rows), together with several large reservoirs, one of which is three miles in circumference, the whole covering two thousand acres of land. The sea water is let into the larger reservoirs, and from there is pumped by windmill into the smaller ponds, and from one pond into another, each pond increasing in the density of its solution. When a saturated solution has been obtained, the salt crystallizes upon the surface; it then falls to the bottom of the liquid, where it accumulates. When it has collected to a depth of three or four inches, it is raked out and piled on platforms to dry. The crude material thus obtained is shipped from these works to San Francisco, where it is manufactured into the finer grades of salt by the American Salt Company. In their works the salt is placed in galvanized iron driers, heated by steam, each drier having a capacity of twenty-two tons per day. When thoroughly dried it is ground in burr mills to various degrees of fineness, for dairy and household use. The capacity of the California Salt Works at Mount Eden is fifteen thousand tons per annum; that of the mills of the American Salt Company in San Francisco one thousand two hundred tons per month.

CHROMITE.

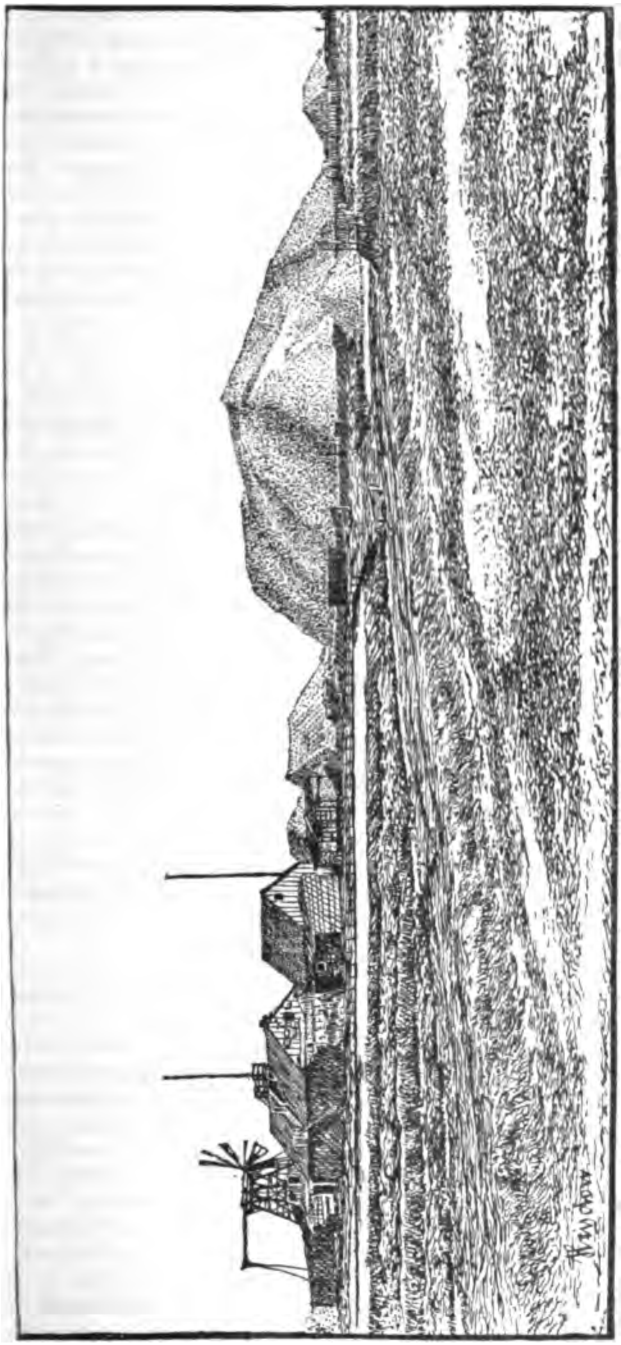
A large body of this mineral has been mined at Cedar Mountain, which rises to the height of three thousand nine hundred feet, in the southeast corner of the county.

DOUGLAS MINE.

A steep ascent of several miles from the Livermore Valley leads to the Douglas Mine, which is situated in the S.W. ¼ of Sec. 26, T. 4 S., R. 3 E., M. D. M., and is nearly a mile from the top of the mountain. It consists of a series of tunnels and cuts, exposing irregular veins and masses of chromite, sometimes six feet or more in width, and in places pinching to a few inches, as is customary with such deposits. About three thousand tons of this ore have been shipped, the price obtained being $10 per ton, free on board the cars at Livermore.

CEDAR MOUNTAIN CLAIM.

This property is situated almost at the summit of the mountain, on the S.E. ¼ of Sec. 26, T. 4 S., R. 3 E., M. D. M. The opening is on the north side of the summit on this claim, in an incline now partially choked with debris; a body of chromite two feet wide is here exposed. About forty yards to the north, further down the mountain, a tunnel penetrates the



CALIFORNIA SALT WORKS.

hill for a distance of a little over one hundred feet. It is cut in a light colored, decomposed serpentine, in which all the chrome deposits of Cedar Mountain occur. The chromite is found in pockets and masses, distributed through this rock. At the end of the tunnel there is a little chromite scattered through the formation, but, like all chrome deposits, it is likely to open out again into masses and pockets of various dimensions. About a quarter of a mile to the south, upon the southern slope of Cedar Mountain, are the lower workings of the Cedar Mountain claim. They are a series of prospect holes, tunnels, and cuttings, disclosing a broken vein of chromite that appears to have exhibited the characteristic eccentricities of that mineral. About two thousand tons of chromite, all told, have been taken from the claim, and sold for $10 per ton. At several points upon Cedar Mountain are prospect holes which have yielded a small amount of chromite.

BUILDING STONE.

There is much excellent building stone in Alameda County, in many places so situated as to possess exceptional facilities for transportation.

ALTA MONTE QUARRY.

This quarry is situated about half a mile from the station of that name, on the Central Pacific Railroad, and about fifty or sixty feet of excellent freestone is here exposed by quarrying. The strata dip to the southwest, at an angle of about 30 degrees. Blocks of stone thirty by six by six feet can be readily obtained. The owner, a practical quarryman, states that almost any size that may be required can be taken out. This rock is of a superior quality of gray sandstone, and was chosen for the construction of the Polytechnic Institute, in San Francisco, and for the last fifteen years it has been used for cemetery work and building purposes. It can be put free on board the cars at Alta Monte for 70 cents per cubic foot. The most peculiar feature of this formation is the rounded bowlders which are found embedded in the sandstone. These are of all sizes, running from a few pounds to many tons in weight. They are a much harder rock than the sandstone in which they are inclosed, and are evidently water worn bowlders, owing their spherical shape, no doubt, to attrition in pot holes, like the spherical stones and bowlders in the Upper Stanislaus and Tuolumne Rivers.

BUILDING STONE TO THE WEST OF LIVERMORE VALLEY.

A smooth working freestone occurs abundantly in the hills which shut in the Livermore Valley upon the east. It has been quarried to a limited extent, one mile from the village of Suñol. That principally utilized is the displaced sandstone rocks from the slopes of the hills and the creek beds. These afford an excellent building material, being durable and taking a fine finish, although exposure to the weather has made them harder to work than the freshly quarried rock. This sandstone crops out upon the land of the Suñol Improvement Company, about three hundred yards from the Central Pacific Railroad, in the western outskirts of Suñol; indeed, at many places along the line of railway through the Suñol Cañon, at the point referred to, where a small quantity of stone has been taken out, the strata dip to the south at an angle of 50 degrees.

THE FARWELL QUARRY.

Further westward up the Alameda Cañon is the sandstone quarry of Mr. J. D. Farwell, three and one half miles northeast of Niles, in Sec. 2, T. 4 S., R. 1 W., M. D. M. This quarry has been worked since 1868. It is one mile from the Central Pacific Railroad. Stone from this quarry was used thirty years ago for monuments in the Centerville cemetery, which are still in a good state of preservation. It was also used in the piers and abutments of the bridges on the Central Pacific Railroad through Alameda Cañon, and appears all the harder for the exposure. Hewn slabs eight feet by one and a half feet by ten inches have been taken out, and blocks that have weighed over four tons. This stone was also used in the Baldwin building, on Market Street, San Francisco, and in the building of the Fisher Packing Company, on Commercial Street, and for bases and copings in the cemeteries. There are three varieties of stone in this quarry—a drab, and a fine and coarse gray variety. The coarse gray and the drab occur in the first portion of the quarry, and the fine grained gray about half a mile further up the cañon. The strata here dip a little to the west of south at an angle of about 70 degrees. Of the coarser grained gray rock, there are some half a dozen strata, varying from two and a half to ten feet in thickness. Above the coarse gray and underlying the drab colored sandstone is a stratum of conglomerate about five feet in thickness. The drab colored sandstone which maintains pretty much the same dip and angle as the gray, consists of a series of strata aggregating probably over one hundred feet in thickness, but it is so covered with earth and brush as to make anything like accurate measurement a matter of difficulty. The fine grained gray variety crops out about half a mile to the northwest of the quarry now opened. An extensive ledge is disclosed dipping approximately at the same angle as the strata in the quarry below. No work has yet been done upon it, but it is an available source of an immense amount of building material. Several sandstone quarries have been worked in the neighborhood of Haywards. That of J. Houcherincho, eight and a half miles from Haywards; J. Dobble's, seven miles, and the quarry of Eudice & Rue, three miles. The stone is of fair quality, and some has been shipped to San Francisco, but the distance to the railroad precludes it from anything but local use.

LIME.

Lime was formerly manufactured at Mission San José, but scarcity of fuel compelled an abandonment of the enterprise. There are two kinds of limestone in the neighborhood—a white chalky variety, which may be seen cropping out below San José Peak, and a compact fossiliferous limestone, which is exposed underlying the sandstone at the landslide on the same mountain.

MANGANESE.

The manganese mine in Corral Hollow has not been worked since the spring of 1887. Over one hundred tons of manganese ore are said to be lying on the dump.

MINERAL SPRINGS.

The Aqua de Vita Springs are situated in the Arroyo Mucho, southeast from Livermore, upon the foothills of Cedar Mountain. Here are four principal springs, around which the proprietor, Mr. Mendenhall, is building up a popular resort. Upon the side of the ravine in which they occur

are two cold mineral springs, an analysis of which, by Messrs. Falkenau & Reese, of San Francisco, gave:

	Grains in One Gallon.
Calcium Carbonate ($CaCO_3$)	15.500
Magnesium Carbonate ($MgCO_3$)	8.893
Sodium Sulphate (Na_2SO_4)	12.446
Sodium Chloride ($NaCl$)	3.687
Silica and Alumina (SiO_2, Al_2O_3)	.420
Grains	40.946

At the bottom of the ravine are two sulphur springs. The adjacent hills are formed of sandstones, shales, and conglomerates, in all stages of metamorphism. In the immediate neighborhood manganese and marble are said to have been discovered, while upon the Aqua de Vita ranch itself ocherous earths, both red and yellow, occur abundantly, yielding a natural paint which is in considerable demand for local purposes. A cutting upon the grade leading down to the spring exposes three or four feet of this ocherous deposit.

MISSION SAN JOSÉ HOT SPRINGS.

About two miles southeast of the Mission of San José are the most notable warm springs in Alameda County. There are four warm springs on this ranch, the waters of which are said to reach the temperature of 80 degrees Fahrenheit. The water of these springs does not deposit any sinter, but is constantly bringing up sand, which necessitates the cleaning out of the springs from time to time. The taste of the water is pleasantly saline and slightly sulphurous. Intermittent bubbles of gas rise with the water. This gas does not appear to be inflammable, and is most likely carbonic acid. The medicinal value of these waters was well known to the Mexicans in the early days of California history.

ALPINE COUNTY.

The name of this county denotes its origin, the topography and scenery of the region it covers being of the most pronounced Alpine type. For boundaries this county has the State of Nevada on north and east, Mono County on the east, Mono and Tuolumne Counties on the south, and Calaveras, Amador, and El Dorado on the west.

TOPOGRAPHY, SCENERY, ETC.

Alpine is a mass of mountains, cleft by a few deep valleys, its altitude ranging from four thousand five hundred to eleven thousand feet above the level of the sea. Half the county lies along the easterly slope of the Sierra Nevadas, its westerly boundary being the crest of these mountains. Standing to the east is the lofty outlying peak known as Silver Mountain, connected with the main Sierra by a notched and jagged cross chain, which, seen from the north, presents a contour diversified along its whole extent by precipitous cliffs, turreted rocks, and far upshooting spires, resembling at some points a vast cathedral, and at others a castellated ruin. There is not in the State a more picturesque, wild, and broken district than this.

Few counties in California are better watered and timbered than Alpine. The two main forks of the Carson River, having many confluents, some of them large streams, traverse the county centrally from north to south.

These streams serve the double purpose of furnishing conduits for floating down timber and fuel to the country below, and an immense water power, which can be made easily available for the propulsion of machinery. Although most of the timber in the valley and along the foothills has been cut away, the Comstock mines having obtained much of their timber and fuel here, the mountains further back are still covered with heavy forests, the inroads made upon them by the woodman being inconsiderable.

THE MINES.

The lower middle portion of Alpine abounds with gold and silver-bearing lodes, a majority of them being of regular formation and large dimensions. But the most of the ores here, besides being of rather low grade, are apt to be more or less base, rendering their reduction difficult and somewhat expensive. As a consequence, the business of mining for the precious metals, began here more than a quarter of a century ago, has not proved generally successful. The county has, in fact, had an unfortunate, not to say disastrous, mining history. The above natural difficulties have been supplemented by a good deal of bad management, some of it due to ignorance and inexperience, and some perhaps to causes less excusable. But then it must be remembered that the work performed here at the start was done under the confusion and excitement incident to the Comstock discoveries, when all were novices in silver mining.

The bullion output of Alpine, never much larger than it is at present, ranges from $30,000 to $35,000 per annum. That this amount will undergo early increment, and ultimately, perhaps very soon, reach much larger proportions, we have good reason to believe. Besides plenty of good timber close at hand, and much water power that can easily be turned to practical account, most of the lodes in this district, by reason of the steepness of the mountains in which they occur, can be exploited to great depths with comparatively short tunnels. In addition to gold and silver, this county contains valuable deposits of copper, lead, and iron.

"Uncle Billy Rogers" Copper Mine—Situated in Hope Valley, in the northwest angle of the county, is said to be the first deposit of this ore ever opened in California or anywhere on the Pacific Coast; the considerable developments here ante-dating the Comstock discovery by several years.

MONITOR DISTRICT,

Northeast from Markleville, was from 1860 to 1880 the seat of extensive mining, having had within a radius of four miles several mines in full operation. The most important ones were, Colorado No. 2, Advance, Lincoln, Last Resort, Manchester, Winchester, Highland Mary, Globe, Imperial Group, Colorado Group Nos. 3 and 4, Hercules, Live Oak, North Colorado, North Tarsus, and Union.

The Colorado No. 2 has been worked more extensively than any other mine in the district. The mine was worked by a tunnel which is at present inaccessible. A large quantity of ore was taken out of the mine at different times and worked at the company's mill, situated at the mouth of the tunnel. The mill has twenty stamps, with a roasting furnace of the reverberatory class, capable of roasting about three tons of concentrates in twenty-four hours. The method of extraction is by battery, then run over Frue concentrators, and the concentrations roasted, chlorinated, and lixiviated. The ore is found in the Colorado in chimneys or deposits. The mineral exists in the form known as sulphurets. From information re-

ceived over $100,000 were taken out of the mine. During the working of this mine no walls were encountered, but judging from the surface indications the walls are porphyry. The mine and mill are at present inactive.

The Advance Mine is an extension of the Colorado No. 2 on the south, and is developed by a shaft four hundred and fifty feet deep. From this shaft several crosscuts and drifts were run, taking out a large quantity of ore, which was milled at the "Old Confidence" mill on Carson River, about two miles from the mine. The method of extraction was by the "Washoe" process. At present the mine is inactive.

The Lincoln Mine is an extension of the Advance, lying south. A tunnel was run to a distance of four hundred feet, but the funds becoming exhausted work was suspended.

The Last Resort is another prospective mine south of the Lincoln, upon which a tunnel was run to a distance of five hundred and forty-eight feet, but was then discontinued. The tunnel will have to be driven several hundred feet more before it will crosscut the ledge.

The Flint Mines, south of the Last Resort, are also prospective mines. There are four locations in the Flint group, of six hundred by fifteen hundred feet, covered by a United States patent, but they are not being worked.

The Marion Mine is a parallel vein to the Advance, southeast. It was worked through a tunnel five hundred and fifty feet long, which crosscuts the vein at a depth of one hundred and fifty feet. A large quantity of ore taken out is now upon the dumps, and is said to be good milling.

MOGUL DISTRICT

Is situated north of the Monitor, and has within her boundaries several mines.

The Morning Star Mine is developed by a shaft and tunnel. Shaft, two hundred and twenty-five feet; tunnel, one thousand two hundred feet. The tunnel was run from Mogul Cañon, and strikes the shaft at a distance of one hundred and fifty feet from the surface. At the point of intersection of the tunnel with the shaft, a drift was run one hundred and fifty feet north, at which point a winze was sunk forty feet. All of this development was done on ore. The ore is difficult to handle and expensive to work, being in the form of enargite. The walls of the mine are porphyry. In 1882 Mr. Louis Chalmers purchased the mine and took out about seven hundred tons of ore, which is said to have paid handsomely for the expense of reduction.

The Polaris Mine, now being worked by Messrs. Coleman and Hawkins, is supposed to be an extension of the Colorado Mines, north. A tunnel is being run along the course of the vein to tap a prospective ore shoot which crops out at the surface, and carries much galena.

The O'Byrne Mine lies to the northwest of the Polaris, and is developed by tunnel and shaft.

The Leviathan Copper Mine is on the east side of Mogul District. The property is developed by two tunnels, six hundred and one thousand feet in length, respectively, the latter tapping the ledge at its face at a vertical depth from the surface of three hundred feet.

SILVER MOUNTAIN DISTRICT.

The IXL Mine is situated about one and one half miles from the town of Silver Mountain, in Scandinavian Cañon. A shaft is sunk to a depth

of four hundred feet in the mine, but at present is inaccessible. A twenty-stamp pan mill was built for this mine in 1876, but was never operated. For what reason could not be ascertained. The ore taken out of the mine was milled at the Exchequer Mill. The mill is an eighteen-stamp roasting mill, and was built to work the ores from the IXL and Exchequer Mines, both mines and mills being owned by the Isabella Mining Company. At present the two mines are inactive, through the absence of Mr. L. Chalmers, who is in London on some business connected with the tunnel which he is running to crosscut the IXL and Exchequer Mines. This tunnel was commenced some years ago, and is in a distance of four thousand four hundred feet, or about halfway towards the mines. When it crosscuts the ledge it will have a length of eight thousand five hundred feet, and a lift of two thousand feet.

The Lady Franklin Mine is situated on the south side of Scandinavian Cañon, and was worked by shaft to a depth of about two hundred feet. Some ore was taken out; the assay value not known; remains in the dumps.

The Pennsylvania Mine, south of the Lady Franklin, is a prospective mine, and is developed by a tunnel eight hundred feet long crosscutting the vein at a depth of five hundred feet from the surface. There is some ore upon the dump, the value of which is not known. Width of the vein is six feet. Both the walls of the mine are granite, and upon the footwall there is a gouge of clay about three inches thick.

Garfield, formerly the Washington Mine, to the southeast of the town of Silver Mountain, has a prospecting tunnel running three hundred feet in country rock and four hundred and fifty feet along the line of the vein, reaching a vertical depth of one hundred feet from surface. Average width of vein about eighteen inches. The gouge along the footwall is about three inches thick. The walls are slate. Mammoth, Silver Creek, and Mountain Mines lie to the northwest of the Garfield.

The Mammoth Mine is opened by a tunnel one thousand feet in length, five hundred feet from the end of which a drift was run four hundred feet to the northwest, but encountered only a small seam of quartz.

Silver Mountain is a prospective mine, and has two tunnels, one of eighteen hundred feet and one of three hundred feet. In the eighteen hundred-foot tunnel a seam of quartz was crosscut at a vertical depth of about three hundred feet from the surface. This seam appears to be the vein or ledge, and it is possible that further developments may uncover a ledge of some value. The work on this property was done in 1864, when mining was carried on without the knowledge or appliances of the present time.

SILVER KING DISTRICT,

Northeast of Silver Mountain, was in 1864 the seat of large mining explorations. A large quantity of ore was extracted from these mines, and milled at a profit. It may be that with the present cheapness of labor and improved appliances many of the mines of Alpine County could be profitably worked. The formation of the country rock in Silver King District is slate and porphyry, and has a northwesterly and southeasterly direction. At present there are no developments being made.

West of Markleville four miles, in Hot Springs Valley, are situated hot springs said to be noted for their curative properties. In this valley is a large deposit of limestone of a very good quality.

HOPE VALLEY AND BLUE LAKES JOINT DISTRICTS.

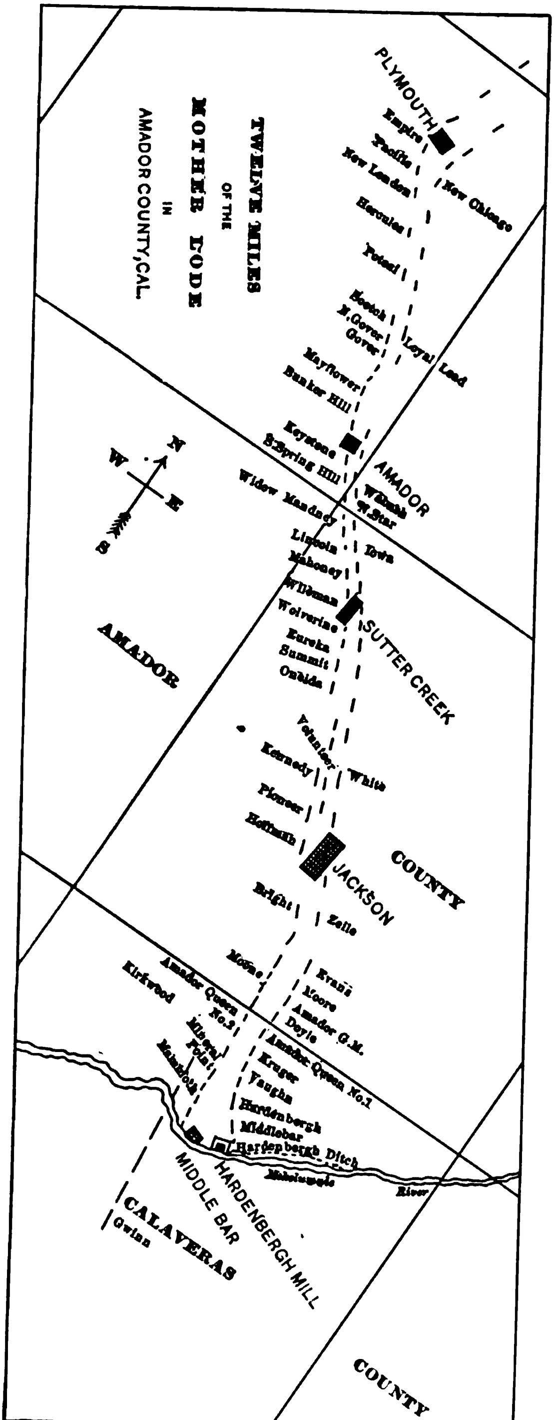
The Altura Mine is the principal mine in this district, and one of the oldest worked mines in Alpine County. The claim was first located in 1856, and work has been done on the mine from time to time up to the present. It was worked by the Oak Valley Mining Company previous to 1864, and since that date by Mr. Barnes, who has sunk a shaft one hundred and sixty feet deep, erected hoisting works and outbuildings. The shaft in about the center of the vein is in ore of low grade. At the bottom of the shaft two crosscuts were run without having encountered either wall; one towards the foot-wall a distance of thirty-five feet, the other towards the hanging-wall a distance of sixty feet. The ore was worked at the Mexican Mill, on the Carson River, and a fair return received. Two other shafts, of seventy-five feet and thirty feet deep, respectively, are sunk south of the main shaft, and show the same indications as the latter. In either case no walls are met with, but according to surface indications the walls are slate and granite. A tunnel was started about six hundred and fifty feet from the main shaft and run to a distance of thirty feet. Should this be continued and crosscut the vein it would leave banks of two hundred and sixty feet on each side of the shaft. In running the crosscut toward the hanging wall, ore containing an appreciable quantity of nickel was found.

Nil Desperandum is a prospective mine south of the Altura, has a shaft one hundred and twenty feet deep, and a tunnel one hundred and fifty feet long, which crosscuts the vein about one hundred feet from the surface. The average width of the vein is about twelve feet, and the ore is of low grade. In the shaft, at a point sixty feet from the surface, a drift was run along the line of the vein a distance of sixty feet, showing much low grade ore. The walls are slate, with a clay gouge resting on the footwall.

The Round Top and the *Black Mines* are two prospective mines south of the Nil Desperandum. Round Top has a tunnel five hundred feet in country rock without having reached the vein. The surface indication looks favorable; the Black has a shaft fifty feet deep in ore of low grade; nothing.

The New York Mine has a tunnel one hundred and fifty feet in country rock, which crosscuts the vein twenty feet wide at a vertical depth of one hundred feet from surface. The walls are slate, with a good clay gouge of about four inches thick on the footwall. The value of the ore is unknown, as none of it has been milled. In this district, as well as other districts in Alpine, are many more prospects which may some day become of value to our mining industry.

The county has not recovered from the setback received in the early days of its mineral excitement. Its mines and reduction works were principally in the hands of inexperienced parties, who knew but little of mining, and less of metallurgy. The manner in which the attempted development of the mines was made, and the method employed (Washoe process) to recover the precious metals from the ores showed, in most cases, unpardonable ignorance. I am informed that some of the superintendents knew nothing of what their requirements should be, and that some of the metallurgists scarcely knew the definition of their calling. The lesson has been learned and dearly paid for, but then with our present knowledge of mining and metallurgy a success out of failure is possible, and Alpine County may be soon numbered among the contributors to the wealth of our State.



TWELVE MILES
OF THE
MOTHER LODE
IN
AMADOR COUNTY, CAL.
PLYMOUTH
Empire
Pacific
New London
New Chicago
Hercules
Potosi
Scotch
N. Gover
Gover
Loyal Lead
Mayflower
Bunker Hill
Keystone
S. Spring Hill
AMADOR
W. Star
Lincoln
Iowa
Mahoney
Wildman
Wolverine
SUTTER CREEK
Eureka
Summit
Oneida
Volunteer
Kennedy
White
Pioneer
JACKSON
Bright
Zeile
Evans
Moore
Amador G.M.
Doyle
Amador Queen No.2
Kirkwood
Amador Queen No.1
Kruger
Vaughn
Hardenbergh
Middlebar
Hardenbergh Ditch
River
MIDDLE BAR
HARDENBERGH MILL
CALAVERAS
COUNTY
AMADOR
COUNTY
N
E
W
S

AMADOR COUNTY.

This county, named after one of the old Spanish families of California, is bounded by El Dorado on the north, Alpine on the east, Calaveras on the south, and by San Joaquin and Sacramento Counties on the west.

PHYSICAL FEATURES, TIMBER, ETC.

The eastern half of Amador, extending into the high Sierras, is elevated and rugged, the surface being cut by many deep ravines. In this elevated region are several small but deep and beautiful lakes, the water cold and of surpassing purity. This part of the county is covered with magnificent forests of pine, spruce, and cedar. The western half of Amador occupies the foothill country, more sparsely timbered, but almost as rugged as the mountain section, these foothills being the site of the gold mines. The upper part of Amador is one mass of granite, the geological formation, lower down, consisting mostly of slate, belts of limestone, and diorite (greenstone).

MINES, MINERALS, AND MINING.

Amador, while admirably adapted for fruit and vine growing, possessing also some other agricultural resources, is notably one of our foremost mining counties, its annual bullion product being now the largest, probably, of any county in the State. There are in this county not less than twenty-five quartz mills, nearly all of them in active operation. These mills carry a total of over six hundred and fifty stamps. Along the broad gold-bearing belt, known as the "mother lode" of California, which holds its course across the county, the principal mines and mills are situated, there being here, within a distance of fifteen miles, as many as twenty large companies engaged in vein mining, the properties of nearly all being equipped with first class plants.

Besides her quartz mines and auriferous deposits, Amador produces some copper and coal (brown lignite), and is rich in marble, limestone, freestone, etc. At a number of localities in the county, notably near the towns of Volcano and Oleta, diamonds have been found by the miners engaged in gravel washing. Some of these diamonds have been of fair size and good quality, and occurred in sufficient quantity to have made search remunerative, had the gravel accompanying them been more easily disintegrated. Some of the stones found here sold in the local market for $50 or $60, their intrinsic value having been much greater.

CLIMATE.

Rainfall taken at Sutter Creek, by Frank Howard, Esq. Average annually, from 1874 to 1886, 32.98$\frac{10}{18}$ inches.

Months.	1887.	1888.	
January	2.04		8.22
February	12.57		.85
March	1.64		8.09
April	5.38		.36
May	.12		.16
September	.54	June (to 15th)	.28
November	1.10		
December	5.15		
Total for year	28.24	Six months	12.96

Temperature from February 1, 1887, to February 1, 1888, taken by E. C. Voorheis, Esq.:

Months.	Mean Max.	Mean Min.	Mean.	Highest.	Lowest.
February	51.33°	35.57°	....	63°	24°
March	67.61	40.45	....	77	33
April	69.30	42.10	55.70°	80	32
May	74.00	45.00	....	96	31
June	78.40	54.90	66.65	100	42
July	86.67	55.77	71.22	96	48
August	84.09	54.64	69.36	93	47
September	79.60	54.87	67.23	92	46
October	74.77	50.64	62.70	86	42
November	62.76	41.53	....	70	28
December	53.51	36.00	44.75	60	29
January (1888)	47.61	34.77	41.19	60	*18

MOTHER LODE.

The mother lode, between Plymouth and the Mokelumne River, is covered by United States patents. Near Plymouth there are claims being prospected. Near Drytown a number of mines have formerly been worked, more or less, which are now idle, as for instance the Potosi, Italian, Seaton, and the North Gored; near Amador City, the King, the Little Amador, the South Keystone, Median, and El Dorado; near Sutter Creek (where was situated the famous Hayward's Eureka) undeveloped properties are numerous—the North Lincoln, the Occident, the Comet and Wabash, and Mechanics Mine. Just south of the Eureka the Summit is situated; and on Kennedy Flat, the Clyde, the Volunteer, and the Pioneer immediately adjoining the Kennedy on the south, and partially prospected by its shaft, come the Hoffman & Bright properties; the Doyle in Hunt's Gulch; the Valparaiso near Middle Bar—connected with which is a Huntington mill in operation; the New York Claims; the old Hardenburg Mine and McKinney properties, and many others.

PLYMOUTH CONSOLIDATED MINING COMPANY.

This company has been mining more extensively for years than any other company in Amador County. Its mines, the Empire and Pacific, are situated in the town of Plymouth, at about one thousand and fifty feet above sea level. The course of the vein is nearly north and south, and the dip east from 56 degrees to 57 degrees from horizontal. The dimensions of the claim are four thousand eight hundred feet by six hundred feet. The length of ore shoot is about eight hundred feet. The hanging and foot-walls are of black slate, and usually a black gouge accompanies each wall.

The south shaft is one thousand two hundred and eighty feet deep, measured on the incline, the north shaft is one thousand two hundred feet on the incline, and the Pacific, the vertical shaft, has reached a depth of one thousand six hundred feet. The mine produces about eighteen thousand gallons of water per day. This is raised without the aid of a pump, as it is found to be more economical to use buckets. The National compressor and National drill are employed—one drilling machine being used. Safety nitro powder is used. During the present year the mine met with a dis-

*Lowest temperature ever recorded in Sutter Creek.

aster in catching fire, at a time of great prosperity. This misfortune has caused a temporary cessation of work at the mine.

The cost of sinking the shaft was, by contract, $18 per foot, the contractors furnishing their own powder. Three shafts were sunk through slate; the fourth, or the north shaft, through vein matter. Yellow pine is used for timbering and spruce for guides in the shaft. Timbers, sixteen feet long, twelve to sixteen inches in diameter, are obtained for $2 each; all above sixteen inches to twenty-four inches, $3. Nothing less than twelve inches in diameter at small end is used. Mining and milling are probably accomplished by this mining company at a less rate of cost than by any other company in the county, on account of most judicious and experienced management, and the immense quantity of ore handled, and conducting all sulphuret treatment at their own chlorination works, and owning canals for floating timbers from the mountains, thus securing them at lowest possible price, as well as obtaining a large part of their water for power free of expense, and having greater pressure of water for power than most of their mining neighbors. The ore is free milling, with 1½ per cent of sulphurets, the typical pyrites of the mother lode assaying $125 to $200 per ton. The gold is recovered by amalgamation in the battery and on outside plates. The sulphurets are collected on the vanners and worked by the Plattner process, in reduction works belonging to the company. The company has two mills of eighty stamps each, of modern construction and most approved pattern, and complete in every detail. The cost of the shoes and dies is 4 cents per pound. Tullocks feeders are used in one mill, and sixteen Hendy Challenge feeders in the other.

The company has electroplating works in which it does its own silvering.

The following article was taken from the "Mining and Scientific Press" during the current year:

"The Plymouth Consolidated is one of the largest producing gold mining companies in California. In 1887 the mines of the company produced $736,304 75, and the operating expenses were $297,404 26. This left a profit of $438,900 41. From this twelve monthly dividends were paid, aggregating $375,000, and $46,861 were spent in construction. The surplus, January, 1888, was $98,118 91. In the construction account was the cost of the addition of forty stamps to the Pacific mill and the electric light plant.

"This company was formed June 1, 1883, by the consolidation of the Empire, the Amador Pacific, and the Plymouth Companies. The mines were well developed, and a considerable amount in dividends has been paid. Prior to the consolidation, gold bullion to the amount of about $2,500,000 had been produced.

"The following is a statement of all the receipts and expenditures of this company from its organization, June 1, 1883, to January 1, 1888, a period of four years and seven months:

June 1, 1883.—Cash on hand at time of organization of this company		$153,319 80
Gold bullion produced by the mines as follows:		
To January 1, 1887	$3,068,194 69	
For the year 1887	736,304 67	
		$3,804,499 36
Total receipts		$3,957,819 16
Disbursements:		
Operating expenses	$1,442,074 08	
Construction (since June 1, 1883)	217,626 17	
Fifty-five dividends, averaging $40,000 each	2,200,000 00	
		$3,859,700 25
Cash on hand January 1, 1888		$98,118 91

"The heavy and regular dividends paid by this company are made from ore of no high grade. The average yield of gold last year was $7 59 per ton. There is no place in the United States where cheaper mining and milling can be done than in California.

"During 1887, except when short of water, both the mills ran with great regularity, and crushed in the aggregate ninety-seven thousand tons of ore. The figures of yield and cost are as follows:

Average yield per ton, 1886	$6 18
Average yield per ton, 1887	7 59
Increase yield per ton	$1 41

"The cost of production in 1887 was as follows:

	Per ton.
Mining	$2 34
Milling	39
Saving and reducing sulphurets	17
General expenses—office, taxes, and prospecting	17
Total average cost, including all expenses	$3 07

"The average cost was increased by the remarkable drought, which so reduced the supply of water that for weeks only one half, and frequently but one quarter, of the stamps could be run. It was not until the last week of December that rain fell in sufficient quantities to run all the machinery. The almost entire absence of rain for three months after the usual time is unprecedented. Heavy storms have since followed, and an abundance of water is now assured by accumulation of snow in the mountains.

"The principal mine consists of an immense chimney of ribbon quartz from thirty to fifty feet wide, and three hundred and fifty to four hundred and fifty feet long. There are four shafts, three of which follow the vein, and the fourth—the Pacific—is vertical. This latter has three compartments and is equipped with superior hoisting machinery. Self-dumping automatic skips are used, hoisting three thousand pounds of rock each, with English flat-wire cables. The derrick frame is seventy-six feet high. On the Pacific Claim, Level No. 1 is one thousand and sixty feet below the surface, and Level No. 7 is sixteen hundred feet below the surface. The temperature of the mine is moderate, and very little trouble is experienced from water. No pump is needed, a bucket running a few hours a day keeps the mine dry.

"The two mills have an aggregate of one hundred and sixty stamps, which crush four hundred tons a day. Connected with the mills are forty-eight Frue concentrators for saving sulphurets. The Pacific mill is one of the best equipped in the United States. The chlorination works have proved a gratifying success. All the machinery on the property is run by water power. The water is supplied from the company's own canals, except that used in the Pacific mill, which is furnished under an old contract with the Amador Canal Company. Steam connections have been retained at the shafts, so that in the event of an accident, a change could be made from water to steam at an hour's notice. The quartz mills are the largest in the world, with one exception.

"The company owns extensive water works. In addition to the several reservoirs there are canals as follows: Main, twenty-five miles long, runs from the middle fork of Cosumnes River to Plymouth; South Fork, or Bridgeport, twenty miles long, runs from main fork of the Cosumnes to a point one mile northeast of Plymouth, where it joins the Main canal;

Simpson, twenty-two miles long, runs from the south fork of the Cosumnes River to the reservoir, two and one half miles northeast of Plymouth; Douglass, thirty-four miles long, with lateral branches aggregating fifteen miles more, conveys water from middle fork of the Cosumnes River to Indian Digging; Tyler, four miles long, runs from south fork of the Cosumnes to reservoir at Tyler's ranch.

"In addition to the above there are several branches, and also canals, leading the water from Plymouth to the country below, in all about forty miles, the whole system making a total of one hundred and sixty miles of canal owned by the company.

"The water used for power is conveyed from the Simpson Canal Reservoir, two and one half miles, in iron pipe of eighteen inches diameter. At the Empire and Woodford shafts a pressure of five hundred and fifty feet is obtained, and at the Pacific shaft a pressure of five hundred and sixty-one feet.

"To communicate this power to the machinery no less than twenty-three wheels are required. Of these three are turbine wheels, of the kind known as the 'Leffel' turbine. The remaining twenty are 'hurdy-gurdy' wheels. They are of three varieties, the 'Knight,' the 'Donnelly,' and the 'Pelton.' These water-wheels now run all the machinery on the property, including mills, hoisting gear at the shafts, sawmills, blowers, rock breakers, concentrators, air compressors, ventilators, blasts, and machine shop.

"The canals are also utilized to bring to Plymouth timbers for the mine. Seven or eight thousand logs a year are used. They are large and heavy. Instead of being hauled over difficult roads at great expense, they are easily floated down the canals from the mountains and dropped into the company's yard almost without cost for transportation. The improvements have cost over $500,000, in addition to what has been expended in development of the mine and for operating expenses. The Superintendent, Mr. E. L. Montgomery, has had charge of the property since December, 1879, while Mr. Wm. Jones, the foreman, has nearly completed his thirteenth year of service. Mr. J. J. Herr has directed the affairs of the office at Plymouth for seven years.

"CHLORINATION PROCESS IN CALIFORNIA—DETAILS OF OPERATIONS IN AMADOR COUNTY.

"The following notes on the stamp mills and chlorination works of the Plymouth Consolidated Gold Mining Company, Amador County, California, were read at a meeting of the American Institute of Mining Engineers by George W. Small, E.M., Oconomowoc, Wisconsin:

"'The ore, as it is raised from the mine, has an average assay value of $11 per ton, chiefly in the form of free gold. All the ore goes directly to the stamp mills, of which there are two. The older and larger mill contains sixteen batteries of five stamps each, with one Frue vanner to each battery. The new mill has eight batteries of five stamps, and two Frues to each battery. The large mill is driven by Leffel turbine wheels, with a pressure of eighty feet, and a consumption of six hundred miner's inches of water. The smaller mill is driven by 'hurdy-gurdy' wheels with a pressure of about five hundred and fifty feet, and a consumption of one hundred and fifty inches of water.

"'At both mills the tailings from the stamps pass over about twenty feet of plates on their way to the Frues. In each set of plates the first or upper one is copper; the rest are so called silver plates.

"'The bullion from the stamps is about eight hundred fine in gold and two hundred in silver.

"'The concentrates from the Frues average from 1¼ to 1½ per cent of the ore stamped. They very rarely exceed 2 per cent. I was unable to get the exact assay value of the concentrates, but it is said to vary between $100 and $200 per ton.

"'The concentrates are treated at the chlorination works at the rate of one hundred tons per month. The capacity of the works is somewhat greater than this, but as the supply of concentrates is limited, it is not deemed advisable to work them up any faster.

"'Care is taken to keep the concentrates always damp until they are put into the roasting furnace. If this is not done, a decomposition of the pyrites begins, forming lumps which do not roast, and which consequently cause a loss of gold in the residues from leaching.

"A *Fortschaufelungsofen* is used for roasting. Its dimensions, including firebox, are 12′x80′. The hearth is one continuous plane, but the charges, of which there are three in the furnace at one time, are kept entirely separate. The furnace men call the three compartments the 'drying,' the 'burning,' and the 'cooking' compartments. In the middle, or 'burning' compartment, the ore is spread out very thin, and occupies about double the space of either of the other compartments.

"'The furnace is worked by eight-hour shifts, one man on each shift, and one charge is drawn and a new one added in each shift. The charges weigh two thousand four hundred pounds, and carry about 10 per cent of moisture. The ore averages about 20 per cent in sulphur, and just before the sulphur ceases flaming (in the second division of the furnace) eighteen pounds, or ¾ per cent, of salt is added to the charge.

"'The roasted ore from each shift is kept by itself on the cooling floor until a tankful (about four tons) has accumulated from a single man's shift; then that lot is worked by itself. This enables the person in charge the better to control the roasting, for, if only one lot out of the three is bad, it is presumable that the fault lies with the workman; but if all three are bad, the probabilities are that there has been a material change in the character of the ore, and the roasting process must be altered accordingly.

"'The vats for chloridizing the roasted ore are nine feet in diameter by three feet in height, and are four in number. They are slightly inclined, so that they will drain completely. The bottom of each tank is occupied by a filter about six inches thick, composed as follows: Light strips of three-quarter-inch wood are first laid in the bottom of the tank at intervals of about one foot. Across these strips are laid six-inch boards, leaving cracks of an inch or more between the boards. On top of this loose floor are placed coarse lumps of quartz, and on top of this again finer quartz material, until a total depth of about five or six inches is obtained. Finally, this "sand-filter" is covered by another loose floor, the boards lying crosswise to the loose floor beneath, and pretty close together. This upper floor is intended merely to furnish a shoveling furnace, so as to permit the removal of the leached ore from the tanks without disturbing the filter.

"'The ore to be chloridized must be damp (about 6 per cent moisture). The working test is, to take a handful of the ore and squeeze it, then open the hand, and if the lump immediately begins to crumble and fall apart (not run) the ore has the requisite amount of moisture.

"'The damp ore is screened into the tanks, so that it will lie as loosely as possible, and facilitate the penetration of the chlorine gas. A coarse screen of one-half-inch mesh is used for this purpose.

"'The tanks are only filled up to within about three inches of the top. This is to insure that the entire contents of the tank are covered by water in the subsequent leaching, otherwise there will be great difficulty in washing out all the soluble gold.

"'As soon as the tanks are filled as stated, they are ready for the introduction of the chlorine gas. This is introduced into the bottom of the tank from two opposite sides, and is continued until ammonia held over the ore gives off dense fumes of ammonium chloride. This usually takes about four hours. When this point is reached, covers are placed on the tanks and the cracks are luted with a mixture of leached ore, bran, and water. The gas generators, of which there are two employed at one time in charging a tank, are allowed to work on until they are exhausted; then they are disconnected and the holes in the tank are plugged.

"'The tank is usually charged with gas in the morning, and is left standing for two days. On the third day the ore is leached. The tank is first filled with water, and allowed to stand a few minutes, so that the water may penetrate all the ore. If no more water is absorbed, the liquor is drawn off at the bottom, care being taken to keep the tank full of water during the entire operation, which takes from four to five hours.

"'In charging the tank, a gunnysack is laid on top of the ore, where the wash-water is afterward to be introduced, in order to better distribute the water in the tank and prevent its washing and packing the ore.

"'The liquor from the leaching vats is conducted to settling or storage tanks, and about forty pounds of sulphuric acid (66 degrees B.) is added. (Experience has shown this addition of acid to be advantageous in obtaining a clean product in the subsequent precipitation. *The chemical reaction is, however, by no means clear.*)* It is usually allowed to stand for twenty-four hours, but two hours are quite sufficient. It is then run into precipitating tanks, and the gold is precipitated by a solution of sulphate of iron. The iron solution is added until, after stirring, a further addition produces no purple color. After the gold is precipitated, it is allowed to stand two or, if convenient, three days to settle; then the supernatant liquor is drawn off with siphons into a second settling tank, where any gold that may have been drawn off by the siphons has a second opportunity to settle. The liquor stands in this tank until it is necessary to run it off to make room for another charge. Very little gold is found in this tank, and it is therefore only cleaned out once during the year. In the meantime, fresh liquor has been run into the precipitating tanks upon the gold already precipitated there. In this way, the gold is allowed to accumulate until the semi-monthly cleanup. Except when it is necessary to have them open, the precipitating tanks are kept covered and locked.

"'In making the cleanup the supernatant liquor is siphoned off, the gold gathered up and placed in a filter of punched iron, lined with a sheet of ordinary filter paper, and washed with water until all the acid and iron salts are removed. It is then dried, melted in crucibles, and cast into bars.

"'The works extract from 95 to 96 per cent of the assay value of the concentrated sulphides. Two men, on day shift, attend to all the work of handling the ore after it is washed (the leaching, etc.). The head man receives $3, the other $2 50 per day. Owing to the limited amount of ore

*To this statement an exception must be taken, as sulphurets sometimes contain considerable lead, almost always more or less. By adding sulphuric acid, the lead is precipitated as sulphate, and the liquor, freed from lead, can yield no plumbic sulphate with the gold when precipitated by sulphate of iron, as it otherwise would; hence a cleaner bullion. In one chlorination works, if not more, the sulphate of lead obtained from the settling or "base" tanks, always containing some gold, is collected and sold, and a considerable sum realized for both the *lead* and gold.

allotted to the works, only three tankfuls are leached every four days. The men, however, are employed steadily. The sulphate of iron is manufactured on the spot. For this purpose an ordinary wooden tank about four feet by four and a half feet, standing outside the building in the open air, is used. The tank is kept full of water and supplied with old scrap iron *ad libitum*, and for each charge to be precipitated about forty pounds of acid are added to the tank.

"'The precipitating tanks, which are of wood, are protected from the action of the acids by a coating of "paraffine paint."

"'I append an itemized statement of the cost of handling the ore. The basis of figuring is one hundred tons of ore per month of thirty days. Consumption of chemicals in the leaching department, twenty-four days in each month:

Roasting—		
Three men at $2 50 per day for 30 days	$225 00	
1¾ cords wood at $4 25 per day for 30 days	223 13	
54 pounds salt at ¾ cent per day for 30 days	12 15	
		$460 28
Generator—		
The charge is manganese 30 pounds, salt 34 pounds, sulphuric acid 60 pounds; therefore, for two generators:		
Manganese, 60 pounds per day, 24 days, at $47 per ton	$33 84	
Salt, 68 pounds per day, 24 days, at $15 per ton	12 24	
Acid, 120 pounds per day, 24 days, at $60 per ton	86 40	
		132 48
Acid for settling tanks (40 pounds), and for sulphate of iron manufacture (40 pounds), 24 days		57 60
Wages of leachers, at $5 50, for 30 days		165 00
Salary of foreman		125 00
Total		$940 36

Or, per ton of concentrates, $9 40$\frac{4}{10}$.'"

To this price per ton should be added for assaying, repairing, supplies, insurance, taxes, water, interest on capital invested, deterioration of plant, and proportion of general expenses and superintendence, about $4 additional per ton, making the total cost of working $13 40.

Altitude (aneroid reading)	1,050 feet.
Length of ore shoot	800 feet.
Length of south shaft on incline	1,280 feet.
Depth of ore shaft vertically	1,100 feet.
Vertical depth reached in mine	1,600 feet.
Vertical depth of north shaft	1,020 feet.
Quantity of water raised in twenty-four hours	18,000 gallons.
Character of hanging wall	Black slate.
Character of foot wall	Black slate.
Kind of powder used	Safety nitro, No. 2.
Cost of mining per ton (total mining and milling, $3 07)	$2 34
Cost per foot of shaft (labor and powder)	$18 00
Number of feet timbered	All.
Kind of timber	Round pine.
Cost of timber	$2 to $3 per log.
Length of ditch built	160 miles.
Cost of transport of ore	Nothing.
Number of stamps	160
Weight of stamps	80— 750 lbs. each. 80—1,000 lbs. each.
Drop of stamps	5 to 6 inches.
Drops per minute	90
Duty of stamps (tons in twenty-four hours)	2
Kind of shoes and dies	Iron.
Size and character of screens	Round punched, corresponding to No. 8.
Kind of feeder	Tullock's and Hendy's.
Kind of concentrators	Frue's.
Character of ore	Soft quartz and slate, free milling, and concentrating.
Percentage of sulphurets	1½
Value of sulphurets per ton	$125 to $200

Cost of milling per ton	$0 39
Cost per ton of working sulphurets (already embodied in cost total)	$11 33*
Percentage of value extracted from sulphurets	92 to 95 per cent.
Kind of roasting furnace	Reverberatory.
Head of water used for power	561 to 550 feet.

SOUTH COSMOPOLITAN.

This mine is situated on the mother lode, at an altitude of about nine hundred feet, in Drytown District, about one and one quarter miles northeast of Drytown. It was one of the early locations on the lode, and the property was purchased last year by an eastern party, and incorporated under the laws of the State of Maine. The course of the vein is northwest and southeast; the dip is to the northeast, at an angle of 60 degrees to 61 degrees. The dimensions of the claim are two thousand seven hundred feet by six hundred. The altitude of the mine is about nine hundred feet. There is one tunnel one hundred and ninety-five feet long, and one shaft which is three hundred and ten feet deep on the incline. The formation passed through is black slate. The hanging-wall is diorite; the footwall black slate. The daily yield of water is thirteen thousand two hundred and fifty gallons, which is raised by bucket. Three hundred and fifty pounds of safety nitro powder are used monthly. The labor cost of sinking the shaft was $15 per foot: the total cost being about $25 per foot. The entire shaft is timbered with sawed spruce lumber, which costs at present $19 per thousand feet. The ore is quartz and slate mixed, free milling, bearing some sulphurets, and has all the characteristics of the mother lode in Amador County. The hoisting works are arranged only for steam. Spur-gear and double three-foot reels are used. The engine has a twelve-inch cylinder, and twenty-four-inch stroke; the boiler is fifty-four inches by fifteen feet. The works have a capacity to sink one thousand feet. One half cord of pine wood, costing $5 per cord, is consumed every twenty-four hours. The number of men employed in the mine is thirteen, without the foreman; four men are employed on outside work, or eighteen men in all. The wages are $2 50 and $3 per day; engineers are paid $3. Six men are paid $3 per day, the balance $2 50. The rock is hoisted in a self-dumping skip.

Developments.

One tunnel, length	195 feet.
One incline shaft, depth	310 feet.
One level at two hundred feet in depth, length (north) (This level is in ore all the way.)	185 feet.
Two crosscuts, each	30 feet.
One in foot-wall	107 feet.
One crosscut, west	40 feet.

This work has all been done during the last year. It is proposed to sink five hundred and fifty feet before stopping. After that to open a level every hundred feet—at the five hundred, four hundred, and three hundred stations; bring in water for power; erect a twenty-stamp mill, with Frue concentrators, and use electric lights.

NEW LONDON MINE.

There are eight claims owned by Messrs. Ballard & Martin, situated one mile south of the center of the town of Plymouth. The most noted of them is the New London, which is fifteen hundred feet in length and five

*To this cost must be added its proportion of incidental expenses.

hundred feet in width. The remaining claims are the Martin, Pioneer, Ballard, Humboldt, Central, and two others. All of these are of the regulation area, excepting the Central, which has an irregular shape, having the form of a triangle. The eight locations are on the mother lode, and their combined length is nearly twelve thousand feet. Their general course is nearly north and south, with an easterly dip. The New London vein dips at an angle of about 65 degrees. It has two shoots of ore—one, two hundred feet in length and seven feet in width; the other, called the rich shoot, was drifted on for about sixty-five feet. The apex of this shoot is about eight hundred and forty-five feet from the surface, measured perpendicularly, and nine hundred and thirty feet from the surface, measured on the incline, and is drifted on sixty feet at the one thousand-foot level. A section of this shoot may be represented by the capital letter "A," and the sixty-foot drift by the horizontal line joining the sides of the letter. As the shoot was lengthening as far as exploration has been carried, the sixty-foot drift on the ore has little to do in determining its true length. There are two shafts on the mine; both incline at an angle of about 65 degrees. One has a depth, on the incline, of three hundred feet; the other, in June, had a depth of one thousand one hundred and thirty feet, which has since been extended to one thousand two hundred feet, and reaching a depth of two hundred and sixty-nine and one thousand and twenty feet, respectively. The walls are black slate. On the one thousand-foot level, the black gouge is about ten inches in thickness. The mine makes about twenty-six thousand gallons of water in twenty-four hours. No pump is used, the water being hoisted in a skip holding two hundred and sixty gallons. Six hundred pounds of Hercules powder are consumed monthly. The company has devoted itself entirely to sinking shafts and developing the mine since the commencement of operations. The size of the main shaft is four feet by nine feet four inches, inside measurement, with twelve-inch center brace dividing the two compartments. The small shaft is four by six feet in the clear. Round timbers, hewed on one side, eighteen and twenty inches in diameter, are used. Seventy-five feet per month were sunk, to a depth of ten hundred and forty feet. From this point, to a depth of eleven hundred and thirty feet, about fifty feet were sunk monthly. In the levels, seventy-five to ninety feet were run monthly. The sets of timber are four and one half feet apart; the posts are sixteen inches in diameter and eight feet high. The levels are four feet high, measured clear of timbers. The formation passed through in both shafts has been vein matter and slate. Both shafts and levels are timbered throughout. The cross drifts require no timbering.

Round yellow pine timber is used, and is hauled a distance of sixteen miles. Timber costs as follows (sixteen foot logs, measured at the small end): Poles, six inches in diameter, 30 cents each; poles, eight inches in diameter, 40 cents each; logs, nine inches in diameter, 75 cents each; logs, ten to eleven inches in diameter, $1 50 each; logs, twelve to fourteen inches in diameter, $2 each; logs, sixteen, eighteen, and twenty inches in diameter, $3 each; five-foot lagging, $70 per thousand; six-foot lagging, $80 per thousand.

The new mill in contemplation will be about five hundred feet east of the main shaft. A tramway will connect the mine and mill, and the cost of transportation of ores will be nominal. The company has hoisting works on each shaft, run by steam. In the main hoisting works the boiler is fifty-four inches by sixteen feet. The engine has a twelve-inch cylinder and sixteen-inch stroke. The power is applied with a solid V gear. Three-quarter-inch flexible steel wire ropes are used. The gallows frame is forty

feet in height. The self-dumping ore skip holds one ton. The self-filling water skip is also self-emptying. The bad air is drawn out of the mine by a No. 4½ Baker's blower. On the north shaft the engine is an upright, eight by twelve-inch, and the gear a solid, straight cog.

The number of cords of wood used per day at the large hoisting works is one and one half, at a cost of $4 per cord. The species is pine. Water is brought from the Blue Lake Water Company, and costs $12 50 per month. The developments are: On the main shaft, three hundred-foot level, south drift, three hundred and ten feet; north drift, two hundred and eighteen feet; crosscut west, seventy-two feet; five hundred-foot level, south drift, two hundred and twelve feet; one thousand-foot level, south drift, six hundred feet; north drift, two hundred and eight feet; crosscut east, three hundred feet. During the year a three hundred-foot shaft was sunk. The main shaft was sunk from one thousand and forty feet to one thousand one hundred and thirty feet in depth, and the levels run therefrom. It is proposed to bring in water, and put up a forty-stamp mill, with Frue concentrators.

Altitude (aneroid reading)		1,075 feet.
Length of ore shoot	one	200 feet.
	other	60 feet.
Length of ore shafts on incline	main shaft	1,130 feet.*
	other shaft	300 feet.
Depth of ore shafts vertically	main shaft	1,020 feet.
	other shaft	269 feet.
Vertical depth reached in mine		1,020 feet.
Quantity of water raised in 24 hours		26,000 gallons.
Character of hanging-wall		Slate.
Character of foot-wall		Slate.
Kind of powder used		Hercules, No. 2.
Quantity of powder used (per month)		600 pounds.
Number of feet timbered		1,430 feet.
Kind of timber		Round pine.
Cost of timber		From 30 cents to $3
Cost of transport of ore		Nominal.
Character of ore		Quartz and slate; free milling.
Character of works		Steam hoisting works.
Percentage of sulphurets		1½ to 2 per cent.
Total number men employed		18
Average wages in mine per day		$2 50 to $3
Average wages paid outside work per day		$2 50 to $3
Cords of wood used per day		1½
Cost of wood per cord		$4
Cost of water for power monthly, for steam		$12 50

LOYAL LEAD.

This mine is situated in Drytown Mining District, one mile east of Drytown, and one and three quarters miles northwest of Amador City. The course of the vein is north, 30 degrees west; the direction of the dip northeast, at an angle varying from 40 to 60 degrees; the width of the main ore body is from sixteen to forty-five feet. The dimensions of the property are: Two thousand and forty-six feet in length, and three hundred and three hundred and eighteen feet in width—six hundred feet are three hundred feet wide, and one thousand four hundred and forty-six feet are three hundred and eighteen feet wide. The ore shoots, or one of them rather, is two hundred feet in length, as far as determined; the other is about eighty feet. There are three tunnels on the mine, of the following respective lengths—one hundred and eighteen feet, three hundred feet, and six hundred feet—and reaching a vertical depth from the surface of fifty feet, seventy feet, and one hundred and twenty feet. Both walls are dio-

*The depth on the incline has reached one thousand two hundred feet and drifting is in progress.

rite. The quantity of water coming into the mine is slight, making its appearance only in the bottom of a sump, ten feet below the level of the main ore chamber.

There is very little timbering, as the ground does not require it at present. The timber used is round pine, and costs $1 50 per log sixteen feet in length by about twelve inches in diameter at small end. The distance of the mine from timber is about twenty miles. The company has constructed one half mile of road, put in five hundred feet of fifteen-inch pipe, and five hundred feet of eleven-inch pipe. The ore is transported to the mill by means of a tramway, at a cost, including mining, of $2 50 per ton. Of this amount 20 cents is chargeable to transportation. The ore is crushed by stamps, and amalgamated in the battery and on outside plates. The sulphurets are caught in a riffle sluice and further concentrated in a Cornish buddle. The mill consists of ten stamps, weighing seven hundred pounds each, with copper plates outside and in the battery. The power is water, under two hundred and sixty feet of pressure applied to a Knight's eight-foot wheel. The wheel was one of the first manufactured by Knight & Co., and hence its size.

One man is employed six days in a week at $3 per day to run the car, or to deliver ninety-eight tons of ore. The labor and incidentals bring up the cost of transportation to twenty cents per ton. Cost of shoes and dies per pound, 4 cents; about one fourth the original weight is returned at 2 cents per pound. Wear of shoes and dies per ton of ore crushed, 14 cents. The last set of shoes and dies, weighing one thousand nine hundred and eighty pounds, was worn out in crushing four hundred and ninety tons of ore, or about four pounds of iron were used in crushing one ton of ore.

First cost of 1,980 pounds of iron, at 4 cents	$79 20
Received for 500 pounds old iron, at 2 cents	10 00
Absolute cost of shoes and dies on 490 tons ore	$69 20

It may be here stated that the ore is somewhat harder than the average ore on the mother lode. The quantity of water used in the battery is about two inches, and the mortar is eleven inches wide. Angle slot punched screens are used; slot one half inch, No. 6. Starting with a seven-inch discharge above the new die, the screens are placed vertically and have dimensions inside of the frame of forty-two inches by five and one half inches, and cost $2 each. One screen lasts during the crushing of two hundred and ten tons of ore. The cost of screens will be seen to be a little less than one cent per ton of ore crushed.

Size of apron, forty-eight inches by forty-eight inches; width of sluice, fourteen inches; length of sluice to each battery, twelve feet; size of plates inside of battery, four and one half inches by forty-two inches. The plates are not silvered. Inclination to the foot, in inches, two.

Feeding in the mill is done by hand. Loss of quicksilver per ton of ore worked, is $\frac{47}{100}$ of one ounce on the average. Concentration is done in one hundred and forty-four feet of sluices. The sulphurets thus obtained are reconcentrated in a buddle.

SULPHURETS.

These consist of iron pyrites, with trace of galena, zinc blende, arsenic, antimony, etc. Sulphurets on the surface, near the mother lode, have not the value they contain at greater depths, owing to oxidation and freeing of a portion of gold contents, which appears as free gold. The sulphurets are sold to the chlorination works at Drytown, where $20 per ton is charged

for the reduction, and the cost of hauling is 75 cents additional. The works return 90 per cent of the assay value. The mine and mill are worked by the owners, who are miners and mill men. They allow themselves $3 each per day, and divide the surplus, on a coöperative plan, in proportion to the interest of each.

An eight-foot Knight wheel drives the mill, for which twenty-eight miner's inches* of water are required, costing 20 cents per inch.

The developments consist principally of tunnels and a chamber of ore opened on two hundred feet in length and twenty feet in breadth with a ten-foot winze below it.

Altitude		1,150 feet.
Length of ore shoot		200 feet.
Vertical depth reached in mine		200 feet.
Hanging and foot-wall		Diorite.
Kind of powder used		Giant, No. 2.
Quantity of powder used monthly		50 pounds.
Cost of mining, per ton, including transportation		$2 50
Quantity of steel used for drills, monthly		80 pounds.
Timber, when used		Pine.
Cost of timber, per log		$1 50
Length of road built		½ mile.
Transportation (included in cost of mining)		$0 20
Character of ore		Hard quartz, free milling, with sulphurets.
Character of the works		Free milling gold mill.
Number of stamps		10
Weight of stamps		700 pounds.
Drop of stamps		6 to 7½ inches.
Drop of stamps		85 per minute.
Duty of stamp in twenty-four hours		1½ tons.
Kind of shoes and dies		Iron.
Size and character of screens		No. 6, angle slot.
Water used in battery		2 inches.
Dimensions of apron		48x48 inches.
Width of sluice		14 inches.
Length of sluice		12 feet.
Percentage of gold recovery in battery		80 per cent.
Percentage of gold recovery on plates		20 per cent.
Percentage of sulphurets		1.66
Value of sulphurets		$50 to $80 per ton.
Cost of milling, per ton—		
Labor	$0 64	
Shoes and dies	14	
Screens	01	
Quicksilver	02	
Incidentals	24	
Water	40	
Total		$1 45
Percentage of value obtained for sulphurets		90
Number of men employed in mill		3
Number of men employed in mine		10
Total number employed		14
Average wages in mine, per day		$3
Average wages in mill, per day		$3
Average wages paid outside work		$3
Water used for milling		2 miner's inches.
Head of water used for power		26 inches.
Fall of water		260 feet.
Cost of water		20 cents per inch.

GOVER MINE.

This mine is situated in the Drytown Mining District, on the mother lode, one and one half miles north of Amador City. It was located in early days, and incorporated on May 12, 1872. The average width of the

*The Amador miner's inch of water is supposed to be twelve gallons per minute. It is measured with four-inch pressure, above the top of a two-inch slot in a two-inch plank, giving about twelve pounds per square inch for friction, in two hundred and sixty feet.

vein is from four to four and five tenths feet, and the course northwest by southeast, with a dip to the northeast of about 45 degrees. The size of the claim is about nine hundred feet by three hundred feet, on which is a mine patent. The company owns eleven acres, patented for a millsite, and one hundred and twenty-four acres on which there is an agricultural patent. There are three shoots of ore in the mine. No. 1 opened over three hundred feet in length, with diorite hanging-wall, and black slate foot-wall. No. 2, or middle shoot, in two parts; north part one hundred and thirty feet long, and south part one hundred and fifty feet, or two hundred and eighty feet in total length. The walls of this shoot are black slate on the hanging and foot side. No. 3 has not been determined by exploration.

There are two shafts on the mine, both incline, at an average angle of about 45 degrees. The north shaft is one thousand feet deep, on the incline; the south is seven hundred feet on the incline. The vertical depth of No. 1, seven hundred and seven feet; the vertical depth of No. 2, four hundred and ninety-five feet. The hanging-wall is diorite and the foot-wall is slate. The quantity of water coming in is about seventy thousand gallons daily. No pump is in use. The water is removed by a six hundred-gallon self-dumping and self-filling skip, with valve in the bottom. Giant No. 2 powder, and other kinds of nitro-glycerine powder are used. Five hundred pounds of powder are consumed monthly. The steel used for drills costs $100 every six months. The cost of mining is $2 50 per ton, without allowing for shaft sinking. The cost per foot in running levels, about $3 50 for labor and powder. Cost of the timber used is variable, according to the ground. The number of feet run per day is variable, from one to three, according to the formation.

The north shaft cost about $90,000. The south shaft—machinery and drifts—cost, before any ore was extracted, $110,048 70. The north shaft was sunk in diorite; the south shaft in slate, about sixty feet west of the diorite. The south shaft is timbered entirely. In the north shaft, below three hundred feet in depth, no timbers are used but in sills for the track. Sawed spruce timber is used in the north shaft when timbering is deemed necessary; in the south shaft, round spruce and pine.

Sawed pine or spruce lumber, delivered at the mine, costs per thousand	$20 00
Poles under six inches in diameter at smaller end and sixteen feet long, each	40
Logs, six to ten inches in diameter at smaller end and sixteen feet long, each	1 00
Logs, eleven and twelve inches in diameter at smaller end and sixteen feet long, each	1 55
Logs, thirteen and fourteen inches in diameter at smaller end and sixteen feet long, each	2 00
Logs, fifteen inches in diameter at smaller end and sixteen feet long, each	2 50
Logs, sixteen inches in diameter at smaller end and sixteen feet long, each	3 00
Logs, over sixteen to twenty inches in diameter at smaller end and sixteen feet long, each	4 00
Lagging, five feet long, per thousand	70 00

The timber is distant from the mine from sixteen to twenty miles.

The company built about one half a mile of road around the mine. The ore is transported from the mine to the mill over a thousand-foot tramway, on which the loaded car pulls the empty one back. The cost of transportation is, in labor, 4 cents per ton; in other expense attached, 1 cent, or in all, 5 cents per ton. The ore has all the common characteristics of the rock of the mother lode, in Amador County—quartz, associated with more or less slate, free milling, with about 2 per cent of sulphurets. The ore is crushed and amalgamated in the battery and on outside plates. The sulphurets are concentrated in Hendy pans and in riffle sluices. The tailings are subsequently run over canvas on contract. The contractors pay for the privilege of working the tailings $25 per month. The concentra-

tions caught in the sluices are highest in value; in the Hendy pans, of medium value. The concentrations on canvas are the poorest.

There are two hoisting works on the mine—one over each shaft. Both are run by steam power. The north hoisting works are very complete in every respect, and cost, according to the statement of the Superintendent, $32,000. The mill is run by water power, under one hundred and fifty feet pressure, on a Knight's five-foot wheel. The mill consists of a large rock breaker, twenty stamps, of eight hundred and fifty pounds in weight each, eleven Hendy pans, a clean-up barrel, and one hundred feet of riffle sluice.

Number of stamps	20
Weight of stamps, pounds	850
Drops, in inches	6 to 6½
Drops per minute	85 to 90
Order of drop	1, 3, 5, 4, 2
Height of discharge, in inches	6 to 7
Duty per stamp, tons in twenty-four hours	2¼
Metal used for shoes and dies	Iron and steel.
Cost of shoes and dies, iron per pound	4 cents.
Cost of shoes and dies, steel per pound	9½ cents.

Steel has not been used long enough to determine the wear of material per ton of ore crushed. In regard to iron, four thousand four hundred pounds of iron crushes about two thousand three hundred tons of ore. One quarter of this weight is taken back at 2 cents per pound.* Four thousand four hundred pounds, original weight of shoes and dies, at 4 cents, $176; one thousand one hundred pounds old iron returned at 2 cents, $22; net cost for iron in crushing two thousand three hundred tons of ore, $154; net cost for iron in crushing per ton, $0 67; screens used, angle slot—slot, one fourth inch in length; size or number, six, seven, and eight; dimensions of screen, inside of frame, slightly inclined, are eight inches by forty-six inches.

Plates.

A splashboard is used, covered with electroplate, in front of each battery. It is eight inches by forty-six inches, and inclined toward the battery at an angle of 45 degrees. The upper apron, forty-six inches by twelve inches, is cleaned once a month. The lower apron, forty-six inches by twenty-four inches, is cleaned every other day. The width of plate in sluice is fifteen inches. The length of sluice, plated, to each battery is twenty-four feet; size, inside of battery, six inches by forty-eight inches—Bunker Hill pattern. The outside plates are silvered, one ounce per square foot. The inclination to the foot, two inches. Kind of feeders used—Hendy's, old style. Percentage of recovery in free gold: In the battery, with low grade ore, 50 per cent; in the battery, with high grade ore, 66⅔ per cent. On the outside plates, with low grade ore, 50 per cent; on the outside plates, with high grade ore, 33⅓ per cent.

In working the last twelve thousand tons of ore, one hundred and forty pounds of quicksilver were lost, or a little less than $\frac{18}{100}$ of an ounce per ton. Eleven Hendy pan concentrators are in use in the mill. No record is kept of the amount of water used by them. Percentage of sulphurets, 2; nature of sulphurets, pyrite, with some arsenic and antimony. Value of sulphurets per ton: The last sixty tons caught in Hendy's pan concentrator, $165; the last nine tons caught in sluices, $203; the last —— tons caught on canvas, $115. Fineness of gold in bullion contained in sulphurets, 825; fineness of silver in bullion contained in sulphurets, 175. The

*Local foundries at Sutter Creek deliver shoes and dies at 4 cents per pound; take back old iron on ground at 2 cents.

method of saving sulphurets is by Hendy's pan concentrators, sluices, and canvas. Cost of treating ore per ton, $20. Percentage of value allowed, 92 to 93 per cent. Cords of wood used per day, two; cost of wood per cord, $6; species of wood used, pine.

Steam is used at the hoisting works. The north shaft engine has a cylinder sixteen inches in diameter, and has a thirty-two-inch stroke. The boiler is fifty-four inches in diameter, and sixteen feet long. The south shaft boiler is of same dimensions. The engine is an eight-inch cylinder, with an eighteen-inch stroke. At the mill a five-foot Knight's wheel drives the main machinery, a three-foot Knight's wheel drives the rock breaker, under a pressure of one hundred and fifty feet. One hundred and thirty miner's inches of water are used. Water costs 20 cents per inch—$26 per day.

Developments.

Two incline shafts—north shaft, depth in feet, 1,000; south shaft, depth in feet 700.
250-foot level, length in feet, 400, connecting north and south shafts.
325-foot level, length in feet, 350, connecting north and south shafts.
400-foot level, length in feet, 500, connecting north and south shafts.
500-foot level, length in feet, 450, connecting north and south shafts.
600-foot level, length in feet, 350, connecting north and south shafts.
700-foot level, length in feet, 550, connecting north and south shafts.
800-foot level, length in feet, 50.

These two shafts are two hundred and sixty-two feet apart. All levels below the four hundred-foot are caved, but the six hundred-foot level is still passable.

Developments Made During the Year.

The five hundred level was run two hundred and fifty feet north of the new shaft; on the six hundred level a crosscut was run west three hundred feet; on the four hundred level a drift was run two hundred feet south of the old shaft, and an uprise made two hundred feet through ore; on the three hundred and twenty-five level connection with the new shaft was made; on the two hundred level the company has run one hundred and fifty feet south of the old shaft, and connected the two shafts, and has run north of the new shaft one hundred and sixty-four feet through ore.

It is proposed to bring in water one and one half miles through a fifteen-inch steel pipe, Nos. 12 and 14, one half of each thickness of steel.* This will give four hundred and twenty-three feet of pressure at the mill, and three hundred and forty-eight feet at the hoisting works. It is then expected to be able to run hoisting works, the forty stamps, and sixteen Frue concentrators with one hundred and twenty-five inches of water.

It is proposed to add twenty stamps more to the mill, and sixteen Frue concentrators; to take the water out of the mine from six hundred to one thousand feet; to put in a Knight's improved Cornish pump, run by Knight's hydraulic engine; to place a large sized rock breaker at the mine; to explore the eight hundred, nine hundred, and one thousand-foot levels for the three shoots of ore above; to build an assay office complete, changing room, and company's office; and put electric lights in the hoisting works and mill.

Altitude, about	1,150 feet.
Length of ore shoots	First, 300 feet; second, 280 feet; third, not explored.
Length of north shaft, on incline	1,000 feet.
Length of south shaft, on incline	700 feet.
Depth of north shaft, vertical	707 feet.
Depth of south shaft, vertical	495 feet.

*The pipe is now being laid, and the hoisting works will be running by water power before many weeks. A new reservoir has already been built, costing about $2,500.

Quantity of water raised in twenty-four hours	70,000 gallons.
Character of hanging-wall	Diorite.
Character of foot-wall	Slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used monthly	1,000 pounds.
Cost of mining per ton, including dead work (except sinking)	$2 50
Cost per foot of tunnel (labor and powder)	$3 50
Cost per foot of main shaft (without hoisting works)	$90 00
Number of feet timbered, north shaft	400 feet.
Number of feet timbered, south shaft	700 feet.
Kind of timber in north shaft	Sawed spruce, 14 inches by 15 inches.
Kind of timber in south shaft	Round timber, hewed on one side.
Cost of timber, sawed, per thousand feet	$20
Cost of timber, round, schedule prices:	
Logs 16 feet long, from 6 to 20 inches diameter at smaller end, from	40 cents to $4
Five-foot lagging, each	7 cents.
Length of road built	¼ mile.
Cost of transportation of ore, per ton	5 cents.
Character of ore	Free milling and concentrating.
Number of stamps	20
Weight of stamps	850 pounds.
Drop of stamp	6 to 6¼ inches.
Drops per minute	85 to 90
Height of discharge	6¼ to 7 inches.
Duty of stamp, in twenty-four hours, about	2¼ tons.
Kinds of shoes and dies, at present	Brooklyn chrome steel.
*Size and character of screens	One fourth-inch angle slot, 6, 7, and 8.
Dimensions of aprons	46 by 12 and 46 by 24 inches.
Width of sluice	15 inches.
Length of sluice	24 feet.
Kind of feeders	Hendy's, old style.
Kind of concentrators	Hendy's pan concentrators.
Character of ore	Quartz and slate mixed, free milling, and concentrating.
Percentage of gold saved in battery	50 to 66⅔ per cent.
Percentage of gold saved on plates	50 to 33⅓ per cent.
Percentage of sulphurets	2 per cent.
Value of sulphurets	$100 to $200
Cost of milling	$1
Cost of working sulphurets	$20
Percentage paid for sulphurets on assay value	92 to 93 per cent.
Number of men in mill	6
Number of men in mine	30
Number of men employed on outside work	3
Total number employed	39
Wages in the mine, per day	$2, $2 50, and $3
Wages in the mill, per day	$2 50 to $3
Wages paid for outside work, per day	$2 to $2 50
Wood used	2 cords per day.
Cost of wood	$6 per cord.
Quantity of water used for power	130 miner's inches.
Fall of water used for power	150 feet.
†Cost of water used for power and in batteries per day	$26

There are about seventy-five acres of the Gover Company's land under fence, and about four acres in choice fruit. The building and machinery and hoisting works at the north shaft are said to have cost $32,000; the dump house, $600; the mill, including about one thousand five hundred feet of fifteen-inch pipe, $33,000; the tramway, from hoisting works to mill, $7,000.

BUNKER HILL GOLD MINE.

This mine was located in 1852, and is situated in the Amador Mining District, about one half mile north of Amador City. The course of the vein is north 15 degrees west, and dips 15 degrees north of east, at an angle of about 75 degrees. It has an average width varying from three

*No. 6 screens are used in the center batteries; No. 7 in outside ones.

†Water is sold to this company at 20 cents per miner's inch An accurate record is not kept of the amount of water used in the battery.

to twenty-five feet. The dimensions of the claim are two thousand six hundred feet by five hundred feet. The length of the ore shoot is not determined. The mine is provided with two incline shafts and an adit level. The shafts are three hundred and fifty feet apart. The north shaft is eight hundred feet deep on the incline, and six hundred and eighty feet vertical. The south shaft is four hundred feet deep on the incline, and three hundred and forty-five feet vertical. The adit level is one thousand one hundred feet long, reaching a depth of three hundred feet vertical. The formation of the hanging-wall is diorite (greenstone). The foot-wall is slate. The water is removed from the mine with a Hooker steam pump, running three hours a day, at the rate of sixty strokes per minute. Hercules, No. 2, powder is used, and fifteen hundred pounds are consumed monthly. The cost of mining, per ton, is about $3 35. The cost of running the adit level, for eleven hundred feet, was $3 50 for labor, under contract. The tunnel passes through black slate the entire distance run; four men, making twenty feet per week. The formation passed through in the shafts was black slate. The shafts and tunnels are timbered, sawed pine and spruce being used in the shafts. All other parts of the mine are round timbered. Sawed timber has an average yearly cost of $22 50 per thousand feet. The timber is situated from eighteen to twenty miles from the mine. The ore is hauled from the mine to the mill, over a tramway, and the cost of transportation is 5 cents per ton. The ore is the common ore of the mother lode in Amador County, being quartz and black slate mixed, and free milling, with the exception of 2 per cent of sulphurets, which are saved by concentration. The ore is crushed in a Hendy crusher nine by fourteen-inch; pulverized under stamps, amalgamated in the battery and on outside plates. Concentrations are saved on the Frue vanners, and are reduced at the company's works. The tailings are afterward let out on contract and concentrated on canvas. The mill is arranged for either water or steam power. A four-foot Knight wheel, under two hundred and sixty feet pressure, drives the Hendy crusher, and a six-foot Knight wheel, under two hundred and seventy feet pressure, drives the mill. In case of failure of water for power, the mill is driven by an engine with a seventeen-inch cylinder and three and a half-foot stroke, connected with steam boiler fifty-four inches by sixteen feet long. The pattern of motor is Knight. The discharge is seven inches above the new die. The order of drop of stamps is 1, 5, 2, 4, 3. The number of tons, on the average, crushed, when a No. 8 screen is used, is ninety-nine per day through the month, including stoppages. A trial is being made of steel shoes and dies, to compare with those of iron. The cost of steel is 9½ cents; of iron, 4 cents, with 2 cents per pound returned for old iron. Shoes and dies weighing eight thousand eight hundred pounds will crush four thousand seven hundred tons of Bunker Hill ore before becoming thin enough to be replaced. The old iron remaining will weigh about one fourth of the original weight.

Purchased 8,800 pounds iron, at 4 cents	$352 00
Returned 2,200 pounds old iron, at 2 cents	44 00
Paid out for iron used in crushing 4,700 tons	308 00
Paid out for iron, per ton of ore crushed	$6\frac{5}{10}$ cts.

The water used in the battery and concentrators is eight measured inches, under four-inch pressure above the top of the opening. The screens, one fourth inch angle slot, last twenty days on the average, making the cost of a ton of ore worked, for screens used, about 1.2 cents. The dimensions of the screen inside of frame are forty-six inches by five inches, and

are slightly inclined. Brass wire screens, thoroughly tested, were found very unprofitable. The proper quantity of ore could not be passed through the screen, owing to clogging, and besides requires extra care and attention. The results were otherwise unsatisfactory. The percentage of recovery in gold in the battery (including the splashboards outside), is 90; on outside plates it is 10; the loss of quicksilver is 900 ounces monthly; absolute record, covering a period of six months, is .3 of an ounce per ton, or a little over 1 cent per ton of ore crushed. Sixteen Frue concentrators are used for saving the sulphurets, with lateral motion, at the usual speed of two hundred per minute. The sulphurets are pyrites, with trace of sulphurets of antimony, arsenic, and lead, like all other sulphurets of the mother lode. The bulk of the concentrations is saved on Frue vanners. The sulphurets are roasted with 1 per cent salt, in a furnace which is a combination of a reverberatory and horizontally revolving roaster. The roasted ore is subsequently treated in a lead-lined revolving chlorination barrel, in which the chlorine is generated from chloride of lime by the action of sulphuric acid. Two cords of pine wood are used per day for steam purposes, and one and one fourth cords for roasting, at a cost of $6 per cord. The hoisting works are run by steam. The north shaft is provided with a double eight-inch cylinder engine, and connected with pinion and spur-gear. A splashboard is used on the outside of the battery, eight inches by forty-six inches in size, covered with silvered plate; the size of the apron is three and one half by four feet, and the width of the sluice is fourteen inches by fourteen feet in length. The plate on the inside of the battery is two inches on the perpendicular side, and four and one half inches on the incline side. A strip is introduced underneath to raise the plate, and is removed as the dies wear them. The inclination of the apron is one and one half inches to one foot; the sluice is inclined eighty-seven hundredths of an inch to one foot. Six Templeton, or roller, and two Hendy Challenge feeders are used.

At the south hoisting works a ten-inch cylinder single engine is used. The cost of water is 20 cents per inch; one hundred and five inches in all are used. Eight miner's inches run the rock breaker under a head of two hundred and sixty feet. This water afterwards supplies the batteries and concentrators. Ninety-two inches supplies power to the mill, under two hundred and seventy feet head, and five inches supplies the chlorination and outside works.

Developments.

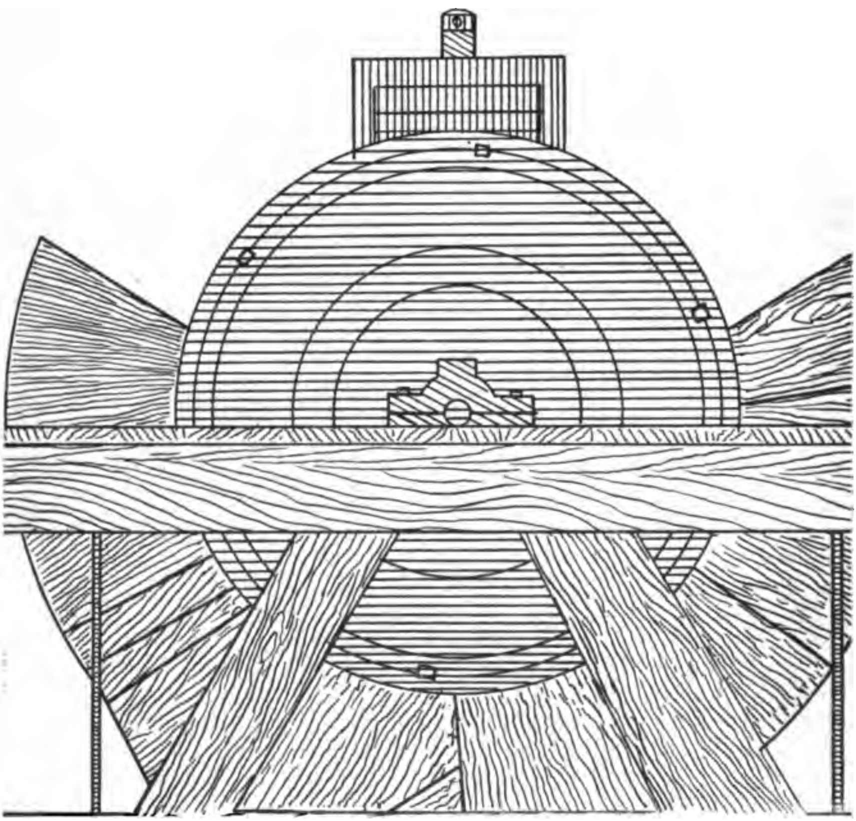
Adit level, 1,100 feet long, attaining 300 feet perpendicular depth.
South shaft, 400 feet on the incline, 345 feet perpendicular depth.
North shaft, 800 feet on the incline, 680 feet perpendicular depth.
On the south shaft, levels were run at 70, 170, 270, and 400 feet in depth. These are not all now open.
On the north shaft—
The 400 level has a length, north 600, and south 600 feet.
The 500 level has a length, north 650, and south 300 feet.
The 600 level has a length, north 600, and south 100 feet.
The 700 level has a length, north 600, and south 150 feet.
The 800 level has a length, north 450, and south —— ——.
All straight line distances.

During the past year the adit level has been driven five hundred feet. All levels were extended from one hundred to two hundred feet north, and large bodies of ore have been struck in the claim.

The milling at the Bunker Hill may be segregated as regards cost, as follows: Shoes and dies, 6½ cents; screens, 1½ cents; quicksilver, 1½ cents; labor, 17 cents; water, 20 cents; incidentals, 14 cents; total, 60 cents.

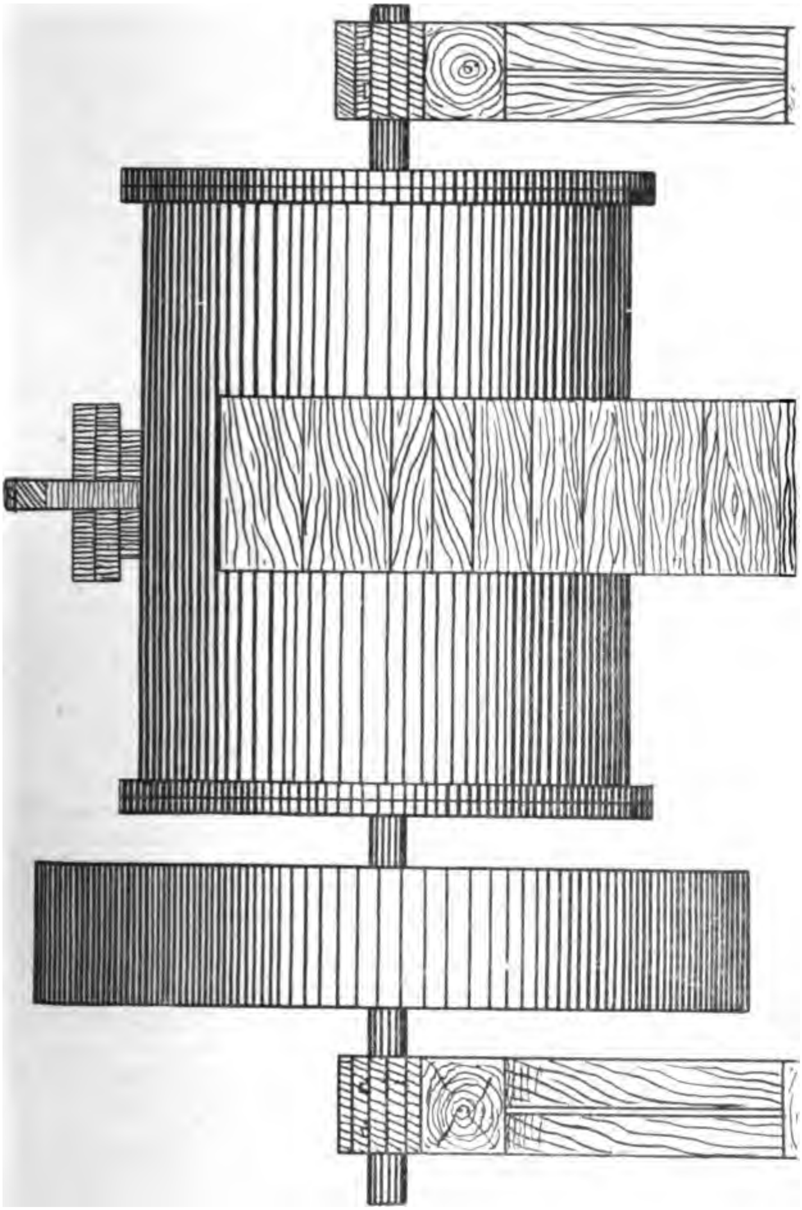
Method of Chlorination.

Description of the chlorination process in use at this mine will be fully explained in this article. This method of working is nowhere else employed on this coast, and the cost has been found to be no greater than the Plattner process, and it is claimed for it a recovery of a very much higher percentage of gold. When the sulphurets from the Bunker Hill are worked by this process but $3 50 per ton remain in the tailings, whereas, when the Plattner process was used on sulphurets of equal assay value, they were found to contain about $7 per ton. Sulphurets containing $57 per ton are worked up to 92 per cent of the assay value by this method, and tailings from $100 sulphurets do not contain any more gold than those of a lower grade. The roasting furnace proper is nine feet wide and forty feet long, outside measurement; the thickness of walls is one and one half feet. The



BUNKER HILL—BARREL USED IN CHLORINATION—END VIEW (¾ inch to 1 foot).

top of the bridge wall is eighteen inches above the grate bars, and nine inches below the center of the furnace arch; the drop to the hearth is six inches. That part of the furnace nearest the bridge wall is a finishing oven, with revolving hearth, twelve feet in diameter, inside measurement, and makes one revolution per minute. The furnace is charged in the same manner as ordinary reverberatory furnaces for roasting sulphurets, and at this mine 1 per cent of salt is introduced with the charge. During the



BUNKER HILL—BARREL USED IN CHLORINATION—FRONT VIEW (⅜ inch to 1 foot).

latter part of the roasting in the finishing oven, different portions of the sulphurets are in succession exposed to the highest action of the heat and oxidizing flame. The capacity of the furnace is two tons in twenty-four hours; the fuel required is five eighths of a cord per ton of sulphurets; the wood employed is pine, and costs $6 per cord. Water for power to revolve the hearth and barrel costs 50 cents for each ton of sulphurets worked (five miner's inches, under two hundred and sixty-foot head, at 20 cents per inch per day). The barrel used for chlorinating the roasted sulphurets is, in outside diameter, forty inches; in outside length, fifty-four inches; inside length, forty-eight inches. There is an opening in the center of the barrel, ten inches in diameter, used for the purpose of admitting and removing the charge. The barrel is lined with one fourth inch of lead of the best quality, and entirely free from zinc. After the charge has been introduced and the cover of the opening is closed, the barrel is made to revolve thirteen times per minute for six hours, when the mass is discharged into a leaching tank of the usual construction. The accompanying drawings will furnish the proper illustrations.

The only skilled labor required in this process is in the roasting. Two tons are worked per day, the barrel being charged twice in the daytime, with one ton at a charge. The leachings from the roasted pulp are treated as in the Plattner process.

The Charge.

One hundred and thirty gallons of water are first introduced into the barrel; thirty pounds of dry chloride of lime, after being mixed on the floor with one ton of roasted sulphurets, are next put in; thirty-six pounds of sulphuric acid, 66 degrees, is then added, and the cover fastened as soon as possible.

Cost of Working.

*Labor per ton	$4 75
Power and water	50
Wood, ⅝ cord at $6	3 75
30 pounds chloride of lime, at 4 cents	1 20
36 pounds sulphuric acid, 66 degrees, at 3½ cents	1 26
20 pounds salt at ¾ cent	15
General expenses—assaying, melting, taxes, insurance, repairing, loss of material in handling, interest, etc.	3 00
Total	$14 61

Altitude (aneroid reading)	900 feet.
Length of ore shoot	Irregular.
Length of ore shaft on incline	800 feet.
Depth of ore shaft vertically	680 feet.
Vertical depth reached in mine	680 feet.
Vertical depth of water shaft	345 feet.
Character of hanging-wall	Diorite (greenstone).
Character of foot-wall	Slate.
Kind of powder used	Hercules, No. 2.
Quantity of powder used (monthly)	1,500 pounds.
Cost of mining per ton	$3 35
Cost per foot of tunnel	$3 50
Number of feet timbered	All.
Kind of timber	Spruce and pine.
Cost of timber	Sawed, $22 50 per thousand; round, from 75 cents to $4
Cost of transport of ore	$0 05
Character of ore	Free milling, with 2 per cent sulphurets.
Character of works	Free milling, concentrating, and chlorinating.
Number of stamps	40
Weight of stamps	850 pounds.
Drop of stamps	6½ inches.

*Two men on the furnace for two tons of ore at $3 25 each; one man at $3 (gas man).

Drops (extreme)	92 per minute.
Duty of stamp in twenty-four hours	2½ tons.
Kind of shoes and dies	At present trying steel.
Size and character of screens	¼-inch angle slot, No. 8.
Water used in battery	8 miner's inches.
Dimensions of apron	3½x4 feet.
Width of sluice	14 inches.
Length of sluice	14 feet.
Kind of feeder	Six Templeton roller and two Challenge.
Kind of concentrator	Frue's.
Percentage of gold saved in battery (including outside splashboard)	90
Percentage of gold saved on plates	10
Percentage of sulphurets	2
Value of sulphurets per ton	$57 00
Cost of milling per ton	$0 60
Cost per ton of working sulphurets	$14 61
Percentage of value extracted from sulphurets	92
Kind of roasting furnace	Reverberatory, with revolving finishing hearth-oven.
Number of roasting furnace	1
Per cent of salt used in roasting	1
Wood consumed in roasting—per ton of ore	⅝ cord.
Number of men in mill	5
Number of men in mine	70
Total number employed	78
Average wages in mine per day	$2 75
Average wages in mill per day	$2 75
Cords of wood used per day	For steam, 2; for roasting, 1½.
Cost of wood per cord	$6 00
Quantity of water used in milling	8 miner's inches.
Head of water used for power	270 inches.
Fall of water used for power	92 feet.
Cost of water for milling, per day	$1 60
Cost of water for power	$18 40

KEYSTONE CONSOLIDATED MINING COMPANY.

This company's property is situated in the Amador Mining District, in the town of Amador. The ores have been mined and milled constantly for twenty-five years, and irregularly for ten years and over. The course of the vein, or, more properly speaking, the course of the three parallel veins, is slightly west of north, and east of south. The dip is a little north of east; the company mines over a space of four hundred feet in width, in which the parallel veins occur, varying in thickness from stringers to sixty feet in width. In dip from 45 degrees to 60 degrees from the horizon.

The property is equipped with two shafts; the depth of the main shaft is one thousand three hundred and five feet on the incline, and reaching a vertical depth in the mine of one thousand feet; the south shaft is used as an air and water shaft, and reaches one thousand and twenty-four feet in depth on the incline, or seven hundred and eighty feet perpendicular. The hanging-wall is diorite; the foot-wall has not been reached. The mine does not make a great deal of water, more however in winter than in summer, and is handled by a bucket in one shaft, and by Cornish pumps in the other, three with ten-inch cylinders, and one with six-inch cylinder; there is a nine-inch column for the ten-inch pumps, and a six-inch column to the six-inch pump.

Giant powder, Nos. 1, 2, and 3, is used in the mine, principally No. 2; one thousand seven hundred pounds are consumed monthly.

The Patton, or main shaft, started in slate near the surface, passed into diorite, and continued in this formation to the bottom. The south shaft was sunk entirely in slate. Both shafts are timbered throughout. Sawed lumber costs at the mine $22 50 per thousand; and five and six-foot lagging from $80 to $90 per thousand.

Pine poles, 6 inches in diameter at smaller end, and 16 feet long, each	$1 00
Pine poles, 7 inches in diameter at smaller end, and 16 feet long, each	1 12½
Pine logs, 8 inches in diameter at smaller end, and 16 feet long, each	1 30
Pine logs, 9 inches in diameter at smaller end, and 16 feet long, each	1 50
Pine logs, 10 inches in diameter at smaller end, and 16 feet long, each	1 62½
Pine logs, 11 inches in diameter at smaller end, and 16 feet long, each	1 87½
Pine logs, 12 inches in diameter at smaller end, and 16 feet long, each	2 00
Pine logs, 13 inches in diameter at smaller end, and 16 feet long, each	2 50
Pine logs, 14 inches in diameter at smaller end, and 16 feet long, each	3 00
Pine logs, 15 inches in diameter at smaller end, and 16 feet long, each	3 50
Pine logs, 16 inches in diameter at smaller end, and 16 feet long, each	
Pine logs, 17 inches in diameter at smaller end, and 16 feet long, each	4 00
Pine logs, 18 inches in diameter at smaller end, and 16 feet long, each	
Pine logs, 19 inches in diameter and over, each	4 50

For spruce, all sizes under twelve inches in diameter and sixteen feet long, the same price is paid as for pine.

Special prices paid for spruce timber:

Logs of spruce, 12 and 13 inches in diameter, 16 feet long, each	$3 00
Logs of spruce, 14 inches in diameter, 16 feet long, each	3 50
Logs of spruce, 15 inches in diameter, 16 feet long, each	4 50
Logs of spruce, 16 to 21 inches in diameter, 16 feet long, each	6 00
Logs of spruce, 19 to 26 inches in diameter, 16½ feet long, each	7 00
Logs of spruce, 19 to 26 inches in diameter, 18 feet long, each	10 00
Logs of spruce, 19 to 29 inches in diameter, 19½ feet long, each	11 00

The mine is about twenty miles from timber. The mine and the mill are in close proximity. The character of the ore is quartz, soft and easily crushed, free milling, with about 1½ per cent of sulphurets. The ore is crushed, pulverized under stamps, amalgamated in the battery and on outside plates, and the sulphurets are saved in the old style, Hendy pan concentrators, in riffle sluices, and on canvas. When running on rich ore, the coarse sulphurets, which are caught in the sluices, assay $135 per ton. From the same ore, concentrations from a Hendy assay $110 per ton. Fine sulphurets, caught on blankets, assay $44 per ton.

In the first five months in 1888, before striking the rich ore, on the lower level—

The sulphurets caught in Hendy pan concentrators assayed, per ton	$96 33
The sulphurets caught in riffle sluices assayed, per ton	71 52
The sulphurets caught on canvas assayed, per ton	44 00
The upper tailings as they leave the mill assay, per ton	70
The lower tailings below the sluices assay, per ton	50

The company's forty-stamp mill is arranged for either water or steam power. A Knight's six-foot water-wheel is used, under two hundred and fifty-four feet of pressure. A steam engine, with a cylinder eighteen inches in diameter, and four-foot stroke, connected with two fifty-four-inch boilers, sixteen feet long, is called into operation in case of failure of water supply. The boilers are supplied with a Freedman's injector, and Knowles' steam pump, No. 5. At the hoisting works there is a Blake's crusher, nine by fifteen inches, and the ore goes broken to the mill.

For one year with No. 6 and 7 straight slot screens, three thousand tons of ore per month were crushed. The order of drop in the Keystone mill is one, two, three, five, four—one and two having a half inch more drop than the other stamps. In the next battery the order is reversed, so on throughout the mill. The inside copper plates are changed from one battery to another, to insure a more even coating of amalgam on the plates with this drop. Shoes and dies are iron and cost four cents per pound. Weight of stamp: Stem, three hundred and ten pounds; tappet, eighty-five pounds; bosses, two hundred and fifteen pounds; shoes, one hundred and twenty-

eight pounds; keys, twelve pounds; total, seven hundred and fifty pounds. Wear of shoes and dies per ton: Forty shoes, five thousand one hundred and twenty pounds; forty dies, four thousand three hundred and sixty pounds; total, nine thousand four hundred and eighty pounds, will crush three thousand tons of Keystone ore. Nine thousand four hundred and eighty pounds at 4 cents, $379 20; less one fourth weight returned, two thousand three hundred and seventy pounds at 2 cents, $47 40; three thousand tons ore used up $331 80 in shoes and dies, or at the rate of $0.116 per ton. Running with a low feed, the Keystone drop wears iron faster than it is worn with other drops, but it is believed also to crush ore faster. The company tried chrome steel; but a set of shoes and dies lasting only sixty days, they were found not to be as economical as iron, where 2 cents per pound are returned for old iron. The screens used are straight slot, No. 8, slightly inclined from the perpendicular. The plates on the aprons are forty-eight inches by thirteen inches. The width of the sluices, of which there are two to each five stamps, is fourteen inches and the length nine feet. The plate inside of the battery is forty-eight inches in length. An end section of the block to which this plate is fastened varies from nothing to two inches on the perpendicular side, on the upper side from 50 degrees to 85 degrees from the horizontal. The plates used are copper and have on the apron an inclination of three quarters of an inch to one foot, and in sluices an inclination of one and one half inches to one foot. The percentage of free gold saved in the battery is about 75 per cent, and on the outside plates 25 per cent.

Loss of quicksilver per ton of ore worked: One year 1,276 Troy ounces were lost monthly in mill, and 10 ounces in retorting, 1,286 ounces; one year 861 Troy ounces were lost monthly in mill, and 10 ounces in retorting, 871 ounces; or an average of 1,078.5 Troy ounces per month for two years. Allowing 14.58 Troy ounces for one pound avoirdupois, 73.97 pounds avoirdupois monthly, at 70 cents, amounts to $51 78. Assuming three thousand tons of ore to have been worked, the quicksilver cost per ton of ore worked would be $1\frac{7}{10}$ cents. The percentage of sulphurets is $1\frac{1}{2}$, principally iron pyrites, with a little arsenical and antimonial* sulphurets; they contain from $80 to $175 per ton. Before striking rich ore last summer, the sulphurets for the first part of the year were running $90 to $95 for the fine and $80 to $90 for the coarse, the alloy of gold in the sulphurets containing about 83 per cent gold and 17 per cent silver by weight. They are saved in Hendy pans, sluices, and on canvas, and sold to the Amador Reduction Works. The charge for treating per ton is $20; for hauling, $1; the percentage of assay value received is 92. One thousand five hundred cords of wood are used per year, at $6 per cord for pine or oak. Both hoisting works are run by steam power. The mill requires one hundred and twenty-five miner's inches of water; in all one hundred and eighty inches are used at the mine and mill, at a cost of $800 per month. Two large sixty-inch and two small eighteen-inch circular saws are in use at the mine for cutting timber, etc.: also Lepley's machine for framing, and a lathe, screw-cutting frame, and the modern appliances. The engine at the Pelton shaft has a twelve-inch cylinder. The engine at the south shaft is an upright—sixteen-inch cylinder and four-foot stroke. The developments on the mine are the Pelton shaft, one thousand three hundred and five feet, and the south shaft, one thousand one hundred and twenty-four feet, measured on the incline, and extensive exploration of the three parallel veins.

*The percentage of antimony increases in depth.

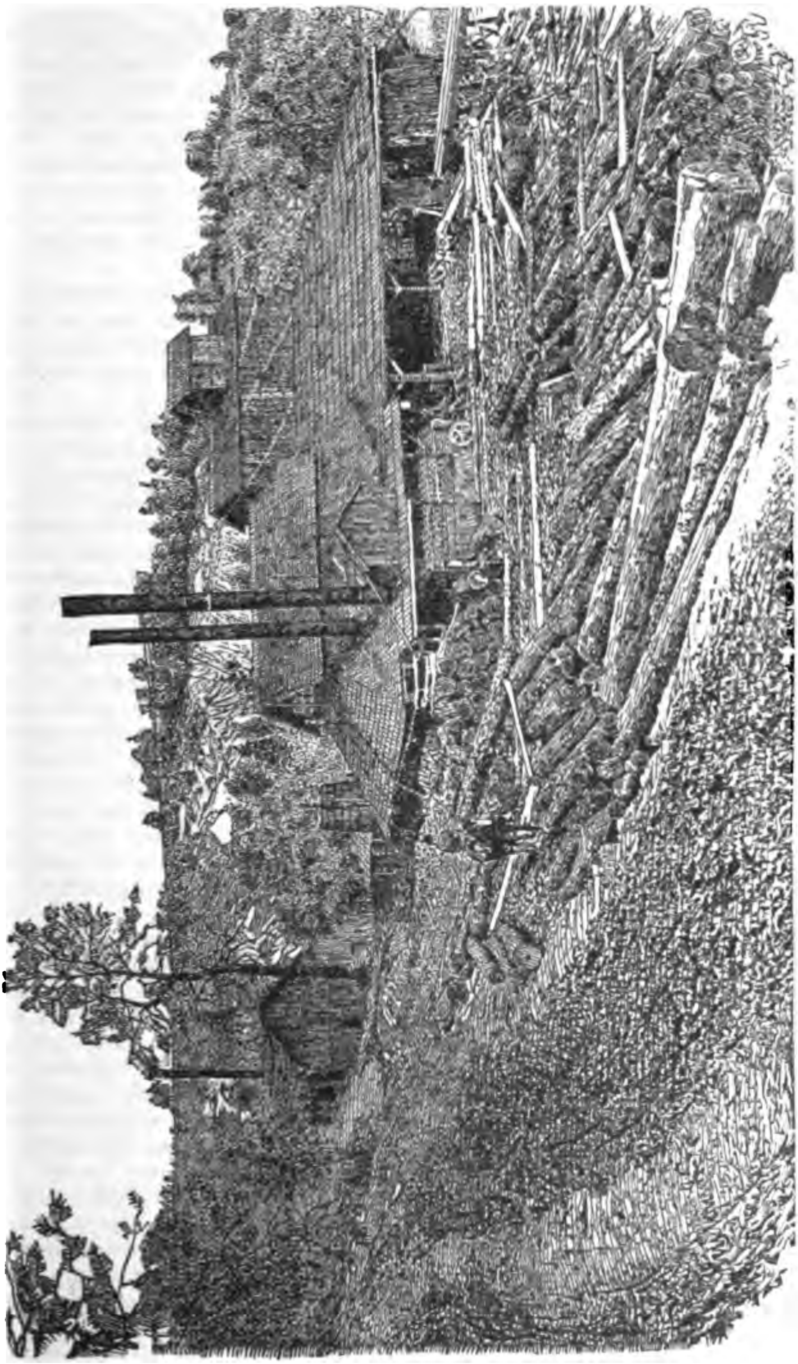
Stations in the hanging wall at each level have a vertical depth of six hundred and twenty, seven hundred and twenty, eight hundred and twenty, and one thousand feet. During the past year a drift was run south on the one thousand-foot level; seven hundred and sixty-seven feet south from the Pelton shaft. It is proposed to sink three hundred feet, and open up levels at greater depths. Milling costs, per ton: Shoes and dies, 12 cents; labor, 27 cents; water, 19 cents; screens, 1 cent; quicksilver, 2 cents; other incidentals, 14 cents; total, 75 cents.

Rich ore has been found in several places in the mine during the present year. Notably on the lowest level in the mine.

Altitude (aneroid reading)	1,000 feet.
Length of ore shoot	800 feet.
Length of ore shaft on incline	1,305 feet.
Depth of ore shaft vertically	1,000 feet.
Vertical depth reached in mine	1,000 feet.
Vertical depth of water shaft	780 feet.
Quantity of water raised in twenty-four hours	25,000 gallons.
Character of hanging-wall	Diorite.
Character of foot-wall	Slate.
Kind of powder used	Giant, Nos. 1, 2, and 3.
Quantity of powder used	1,700 pounds.
Cost of mining per ton	$4
Number of feet timbered	Timbered throughout.
Kind of timber	Pine and spruce.
Cost of timber	According to size, 75 cents to $11, spruce.
Character of ore	Free milling, with 1½ per cent sulphurets.
Character of works	Free milling gold mill, with concentrating pans and sluices.
Number of stamps	40
Weight of stamps	750 pounds.
Drop of stamps	6 inches.
Drops per minute	92 to 93
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	Iron.
Size and character of screens	Straight slot, No. 8.
Dimensions of apron	48 inches by 15 inches.
Width of sluice (double)	14 inches.
Length of sluice (each)	9 feet.
Kind of feeder	Templeton.
Kind of concentrators	Hendy pans.
Number of concentrators	28
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	1½
Value of sulphurets per ton	$80 to $175
Cost of milling per ton	75 cents.
Cost per ton of working sulphurets	$20
Percentage of value extracted from sulphurets	92
Number of men in mill	9
Number of men in mine	25 first hands, 54 second hands.
Number of men, outside work	21
Total number employed	109
Average wages in mine per day	First hands, $3; second hands, $2 50
Average wages in mill per day	$3
Average wages paid outside work per day	$2 50
Cords of wood used per day	4½
Cost of wood per cord	$6
Quantity of water used in milling	125 miner's inches.
Head of water used for power	266 feet.
Fall of water used for power	200 miner's inches.
Cost of water for milling and for power—Nominally use 200 inches of water and pay $800 per month, mine and mill.	

THE KENNEDY MINE.

This mine is situated about one mile north of Jackson, the county seat, on the main stage road to Ione, at an altitude of about one thousand four hundred and seventy feet above sea level. The several properties which form the Kennedy Mine were located in 1860 and patented in July, 1872. The amount of acreage in the mining patent is twenty-seven and eighty-



KENNEDY SOUTH HOISTING WORKS.

five one hundredths and embraces two thousand and sixty feet in length on the mother lode, and a width of about five hundred feet. It lies between the Oneida on the north and the Pioneer on the south, and in addition the company owns a patented millsite of five acres. The general course of the vein is about north 20 degrees west, and the dip north 70 degrees east, at an angle with the horizon varying from 45 degrees to 55 degrees for about four hundred feet, and thence to the bottom the angle is about 60 degrees from horizontal. The width of the vein is from two to forty feet. There are three shoots on the mine—the south chimney, in its greatest length, is four hundred and ninety feet, with intervening spots of barren material, the middle one about two hundred feet, but the length of the north chimney, the existence of which has been known since an early date, has not been determined.

There are two shafts on the property and one tunnel, which are still being driven. The main shaft is about five by twelve feet in the clear, with two compartments and a pump and ladder way, timbered throughout with sawed spruce, sixteen and twenty inches square, and has attained a depth of one thousand one hundred and twenty-five feet.

The north shaft, which is being rapidly sunk, is timbered with sixteen-inch square spruce, and is also a double compartment, and from the four hundred level down is five by twelve feet in the clear. It has reached a depth on an incline (averaging about 70 degrees) of six hundred and seventy feet. The tunnel now being driven to reach the north chimney is about two hundred and fifty feet in, and one hundred feet below the surface. The main shaft, on reaching a vertical depth of four hundred feet, encountered vein matter which it followed at an angle of about 60 degrees until it reached its present depth, corresponding to a vertical depth of one thousand and twenty-five feet from the surface. The north shaft has reached a vertical depth of six hundred and twenty-five feet. The hanging-wall of the vein is diorite (greenstone), the foot-wall slate. The mine yields about sixty thousand gallons of water daily. No pump is used. The water is removed with self-filling, self-emptying water barrels, holding five hundred gallons each. About eight hundred pounds of giant powder, No. 2, are consumed monthly. Of steel, for drills, it is estimated that about four hundred pounds are required. For the last two years the present owners have been developing the mine, sinking shafts, running tunnels, etc., and the mining cost per ton has not been segregated from other work, but $3 per ton may be given as a pretty close estimate.

The labor cost of running the tunnel was $3 per foot; of sinking the shafts (excavation nine by fifteen feet, formation hard slate) is $15 and $20 by contract, and the number of feet sunk per day from one to one and one half. The prices paid for timbers, which are round pine in tunnel, levels, and stopes, are the same as at the Zeile Mine. Sawed spruce or pine costs $20 per thousand. There is no cost for transportation of ore, as the mine and mill are together. The ore, the ordinary mother lode rock, quartz, and slate, free milling, with small percentage of sulphurets, is subjected to the ordinary process of crushing, pulverizing in the battery, amalgamating in the battery and on outside plates, and concentrating on Frue vanners. The sulphurets are sold to the Amador Reduction Works. The mill contains forty stamps, weighing eight hundred and fifty pounds each; the usual drop is started at six and one half inches for soft rock, and seven inches for hard, and eighty-eight drops are given per minute. The duty per stamp is two and one sixth to two and one fourth tons in twenty-four hours, when running with a discharge nine inches above the die, and using Nos. 20, 24, and 30 brass wire screen.

White iron is used for shoes and dies, and costs 4 cents per pound. In regard to wear it varies according to the iron, when the rock and the drop of the stamp are the same—one set of dies lasting thirty days, another thirty-five days. Eight thousand eight hundred pounds of shoes and dies crush two thousand seven hundred tons in one case and three thousand one hundred and fifty tons of similar ore in another case, with the same drop. The wear in one case amounted to $3\frac{26}{100}$ pounds of iron to a ton of ore, and in the other case $2\frac{8}{10}$ pounds. Eight thousand eight hundred pounds of iron, at 4 cents, $352; two thousand two hundred pounds of old iron returned, at 2 cents, $44; net cost of iron, $308 in one case for crushing two thousand seven hundred tons, and in the other for three thousand one hundred and fifty tons. In one case the cost of shoes and dies was $11\frac{4}{10}$ cents per ton of ore; in the other the cost was $9\frac{77}{100}$ cents per ton of ore.

The quantity of water used in the battery and on concentrators is about twelve inches. The screens are brass wire set vertically. The dimensions inside of the screen frame are four inches by forty-four inches. Experiments are being made with Nos. 24 and 30 mesh. The apron is forty-six inches by thirty inches. The width of the sluice is fifteen inches, and eighteen feet in length. A double sluice is used to each five-stamp battery for ten feet beyond the apron. The size of the plate inside the battery is six inches by forty-four inches. Silvered plates are used outside the battery, and the inclination to the foot is $1\frac{87}{100}$ inches. Hendy's Challenge feeders are used. The percentage of recovery in the battery varies from 33 per cent to 66 per cent, and on the outside plates from 66 per cent to 33 per cent. The ore contains $1\frac{1}{2}$ per cent of sulphurets, of an assay value of $125 per ton. About one sixth of the value of the ore is in the sulphurets. The loss of quicksilver is about $1\frac{1}{2}$ cents per ton. Sixteen Frue vanners are used for concentrating. The sulphurets are sold to the Amador Reduction Works, at Sutter Creek, and the percentage of value allowed is 92 per cent of the assay. Steam is only used in case of an accident to the ditch or water power, and then only at the hoisting works. The wood used costs $5 per cord. It requires an average of five cords of wood per day, when running the hoisting works by steam, to hoist sixty thousand gallons of water and one hundred tons of ore from the mine. The water is hoisted from the four hundred, six hundred, and nine hundred levels, and from the sump, which is one thousand one hundred and twenty-five feet deep.

It is proposed to put in power saws for framing timbers and making wedges; to sink both north and south shafts to one thousand one hundred and fifty feet, and connect and run each way; to open up the third, or north chimney, existing on the surface.

The cost of milling at the Kennedy: Water, per ton, $22\frac{1}{2}$ cents; quicksilver, per ton, $1\frac{1}{2}$ cents; shoes and dies, per ton, 10 cents; labor, per ton, 20 cents; incidentals, 15 cents; total, 69 cents.

The company pays for water, 15 cents per miner's inch, under special contract, as the water is turned into the ditch to be used again by the Zeile and other mines on the lode, further south. The daily cost of water for all purposes is $36 75.

Developments.

One tunnel 250 feet long.
South shaft, 1,125 feet deep.
400-foot level, not reopened at present; south, 295 feet long.
600-foot level, south, 240 feet; north, 636 feet; total, 876 feet.
750-foot level, south, 240 feet; north, 100 feet; total, 340 feet.
850-foot level, south, 180 feet; north, 200 feet: total, 380 feet.
950-foot level, south, 240 feet; north, 236 feet; total, 476 feet.
1,050-foot level, south, 60 feet; north, 60 feet; total, 120 feet.

At present the company is drifting both ways from the shaft. Two winzes from nine hundred and fifty to eight hundred and fifty level; one winze from eight hundred and fifty to seven hundred and fifty level; one winze from seven hundred and fifty to six hundred level. Connection is made on the six hundred level between the south shaft and north shaft, six hundred feet apart. North shaft is six hundred and seventy feet deep, measured on the incline. Opening levels, at three hundred and forty-two and four hundred and sixty-four feet from the surface, is in progress.

The hoisting works on each shaft are arranged for working by either water or steam power, independent of each other. The mill is run by water power alone. The hoisting works are complete, and newly constructed. The works at the south shaft are run by two six-foot reversible Knight wheels, under one hundred and eighty-one feet of pressure, or in case of failure of water supply, by a fourteen-inch cylinder engine with thirty-inch stroke, connected with two large boilers. The works at the north shaft are run by Pelton wheels under a pressure of about one hundred and sixty-five feet. The works are also supplied with suitable steam power. The water from wheels of north and south shaft is conveyed by pipe and flume to a large tank, forty by eighty feet square and four feet deep. From water caught in this tank a Pelton wheel, at the mill, under fifty-three feet of pressure, runs the concentrators, and another Pelton wheel runs the rock breakers. The tank also supplies water for the use of the batteries. A five-foot Pelton wheel, under about two hundred and thirty-five feet of pressure, runs the mill. Two hundred and forty-five inches of water are required daily for all purposes; of this amount about fifty-five inches are used at each hoisting works, and one hundred and thirty-five inches on the main wheel of the mill.

The ore is hoisted from the mine in three thousand four hundred-pound self-dumping skips, and the water in barrels, holding five hundred and twenty gallons of water. The barrels are self-filling, self-emptying, and registering. The buckets are shoved from the shaft, by hydraulic engines, under control of the engineer. The piston rod of the engine shoves the frame, on which the bucket rests, on emerging from the shaft. As the frame moves out with the bucket, it is tallied on a marked dial. A counterpoise below the floor moves the frame back to place, with the empty bucket. The power from the water wheel shaft is transmitted to the main connecting shaft by three two-inch manilla ropes, used for convenience of room.

Altitude (aneroid reading)	1,470 feet.
Length of ore shoot	1— 490 feet. 2— 200 feet. 3—Undetermined.
Length of ore shaft on perpendicular and incline	1,125 feet.
Depth of ore shaft vertically	1,025 feet.
Vertical depth reached in mine	1,025 feet.
Vertical depth of water shaft (north shaft)	625 feet.
Quantity of water raised in twenty-four hours	60,000 gallons.
Character of hanging-wall	Diorite (greenstone).
Character of foot-wall	Black slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used	800 pounds monthly.
Cost of mining	$3 per ton.
Cost of tunnel (labor cost)	$3 per foot.
Cost of shaft (labor cost)	$20 per foot.
Number of feet timbered	All.
Kind of timber	Sawed spruce.
Cost of timber	$20 per thousand feet.
Character of ore	Quartz and slate mixed.
Character of works	Free milling and concentrating.
Number of stamps	40

Weight of stamps	850 pounds.
Drop of stamps	6½ to 7 inches.
Drops	88 per minute.
Duty of stamp	2¼ to 2½ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Brass wire, 20, 24, and 30.
Water used in battery	12 inches.
Dimensions of apron	46 by 30 inches.
Width of sluice	15 inches.
Length of sluice	18 feet.
Kind of feeder	Hendy Challenge.
Kind of concentrators	Frue's.
Percentage of gold saved in battery	33 to 66
Percentage of gold saved on plates	66 to 33
Percentage of sulphurets	1½
Value of sulphurets	$125 per ton.
Cost of milling	69 cents per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	92
Number of men in mill	6
Number of men in mine	60
Number of men on outside work	15
Total number employed	81
Average wages in mine	$2 70 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 50 to $4 per day.
Cords of wood used	When used, 4 cords per day.
Cost of wood	$5 per cord.
Quantity of water used in milling	135 inches per day, $20 25
Head of water used for power	165 feet, 181 feet, and 235 feet.
Fall of water used for power	110 inches.
Cost of water for milling	15 cents per inch, $20 25
Cost of water for power	$16 50

TALISMAN MINE.

This mine adjoins the South Spring Hill on the southeast. There is a main shaft on this mine nine hundred feet deep. The present company commenced to take the water out of the shaft about six months ago, and is now drifting north, south, east, and west, principally north to connect with the South Spring Hill Mine. The Talisman is a separate incorporation, but the members of the South Spring Hill Mine are the owners of the Talisman stock. The work is done with power drills, two drilling machines being used. The South Spring Hill compressor furnishes the air for the drills.

NORTH STAR MINE.

A detailed account of operations on this mine is given, as it may prove useful in comparing costs of sinking shafts of similar dimensions, in the foot-wall slate of the mother lode. The North Star Mine is situated near Sutter Creek, on the mother lode, on an unbroken hill. Its immediate neighbors on the south are the Comet, Golden Eagle, and Lincoln, on the north the South Keystone and Talisman, South Spring Hill and Keystone, situated in the order named. June 1, 1887, the North Star Improvement Company was incorporated with the following Directors: E. C. Voorheis, President; H. H. Towns, Treasurer; Dr. J. L. Mayon, Secretary; R. C. Downs, H. Reese, and J. R. Treglon.

A working bond for two years having been secured, water was brought in, and machinery erected sufficient to reach a depth of one thousand feet. The hoisting works, covered by a substantial building, consist of a single friction-gear hoist, driven by a six-foot Donnelly wheel. Water required is six miner's inches per day, and the pressure is about two hundred feet. The company constructed a reservoir having a capacity of running the

works for twenty-four hours, and laid an eleven-inch pipe from the reservoir to the wheel.

The shaft is a single compartment, four feet and one half by six feet, inside measurement, with ladder-way and track. No pump is used. Three thousand gallons of water are hoisted daily from the one hundred-foot level, where the water tank is situated. No water is met with below that point. The formation passed through is country rock—black slate—west of the line of ore body. It is intended to sink to a point six hundred and forty feet below the surface, crosscut at six hundred feet to the ledge, and drift. The sinking has been done through fair blasting ground, using double hand hammers, and nitro-glycerine powder, No. 2. At the annual meeting of this company, the Secretary reported as follows, concerning the operations and financial business, from the commencement of work up to June 1, 1888:

Receipts for 100,000 shares		$2,000 00
Six assessments		12,000 00
Lumber expense	$492 72	
Construction expense	1,850 35	
Labor expense	8,254 50	
Mine supplies	558 38	
Water	363 20	
Timbers	486 10	
Spiling	361 67	
Powder, fuse, etc.	602 42	
Incidentals	359 38	
Balance on hand in treasury, June 1, 1888	671 28	
Totals	$14,000 00	$14,000 00

The shaft was sunk three hundred and seventy feet, at an angle of 60 degrees. Hard diorite (greenstone) was encountered, and work in the bottom of the shaft was discontinued. Three hundred and seventy feet were sunk at 60 degrees, and two hundred and forty feet were sunk at 88 degrees; total, six hundred and ten feet were sunk. On encountering hard greenstone at three hundred and seventy feet, the shaft, at that point, was abandoned, and at two hundred and sixty feet from the surface a new shaft was started, and sunk at an angle of 88 degrees, until a depth of five hundred feet from the surface was reached. A drift forty-seven feet long was also run west from two hundred and sixty feet from surface.

Total sinking of shaft	610 feet.
Size of shaft	4½ by 6 feet.
Total drift	47 feet.
Size of drift	4 by 6 feet.
Labor cost, per foot	$12 56
Tools, steel, mine supplies, per foot	85
Water, per foot	56
Timbers, round, hewed on one side, per foot	74
Lagging	55
Powder and fuse	92
Incidentals	54
Total cost per foot	$16 72

The entire work was accomplished without a single accident, without an hour's stoppage during the entire year. At the present date, September 1, 1888, the shaft has reached the proposed depth, and crosscutting is in progress.

Since the above was written, a very rich body of ore was encountered in crosscutting on the six hundred-foot level.

LINCOLN MINE.

This property lies about half a mile northwest of the town of Sutter Creek, on the mother lode, and for many years was one of the richest mines in the State. It has the same course and dip as the other mines of the lode, which are in proximity. Connected with the mine is a forty-stamp mill, with eight hundred and fifty-pound stamps, run by water power, under a pressure of two hundred and sixty feet. The five hundred-foot level of the Mahoney Mine is connected with the underground workings of the Lincoln. The latter is said to be a very valuable mine to-day; and it is stated was closed down on advice, when there was money in the treasury. While the mine lies idle, twenty stamps of the mill are working ore from the waste dumps.

THE HECTOR MINING COMPANY.

This company owns the Mahoney Mine, a forty-stamp mill, and most of the Hubbard and McAdams ground. The mill has been running about four months of this year, on surface rock. The property is situated on the mother lode, just north of the Wildman, and south of the Lincoln Mine, and is equipped with hoisting works, hydraulic engine, and pump. The mine is developed by a shaft one thousand feet deep, measured on the incline, which is about 56 degrees to the east; the vertical depth reached is about eight hundred and twenty feet. There is a level run from each of the following points: five hundred, six hundred, eight hundred, and nine hundred feet from the surface. The five hundred level connects with the Lincoln on the north. The company proposes to put in an electric plant, and run their hoisting works and mill by electricity. It is also proposed to introduce a two hundred-horse power dynamo, to be run by water power, at the New York Ranch, three and one half miles southeast of Sutter Creek, and convey the electricity to motors at the Mahoney mill and hoisting works. The use of the water power has already been contracted for. There does not seem to be a sufficiently good reason why this property should not be in operation.

SUTTER CREEK MINE.

This mine was one of the early locations of Amador County. It is situated in the Sutter Creek Mining District, about two thousand feet north of the town of Sutter Creek. The course of the vein is northwest and southeast, nearly. The vein at this point, at present depth appears about perpendicular. The average width is thirty feet. The dimensions of the claim are one thousand one hundred feet long by four hundred feet in width. The length of the ore shoot, as far as developed, is seven hundred and fifty feet. It is worked both by tunnel and shaft. The length of the tunnel is two hundred and fifty feet, and the vertical depth reached by it from the surface is sixty feet. The shaft is vertical, and sixty feet in depth. The hanging and foot-walls are diorite. The mine, at present development, is free from water. Giant powder, No. 2, is used at the rate of two hundred pounds per month. The cost of mining is 94 cents, without transportation. The cost per foot in running tunnel is stated at $3, and the number of feet run per day is two and one half. The formation passed through is decomposed diorite and quartz. The length of the tunnel is two hundred feet. The kind of timber used is round pine. Sixteen-foot sticks cost $1 50 each and one and one half sticks are used every five feet. The timber is about twenty miles from the mine. The ore is brought to the mill, over a tram-

way, at a cost of 17 cents per ton. The ore is soft and decomposed. It is crushed with stamps, and amalgamated in the battery and on plates.

The mill is a water power stamp mill, with six by eight-inch rock breaker. No concentrators are used. Blankets, riffle sluices, and Cornish buddles are employed for saving the sulphurets. Hard iron is used for shoes and dies, and costs delivered 4 cents per pound. One set of shoes and dies is worn out in sixty days—about two thousand two hundred pounds in weight, originally, of which amount one quarter is returned as old iron, at 2 cents per pound. The cost of shoes and dies per ton of ore crushed is from 8 cents to 11 cents, according as one and one half or two tons of ore is crushed. The quantity of water used in the battery is two and one half inches. Angle slot No. 8 screens are used; they are placed nearly vertical, and the dimensions inside the frame are six inches by forty-eight inches. The size of the apron is three feet by four, and the width of the sluice is fourteen inches, and the length to each battery is twelve feet. The size of the plate inside the battery is six inches by four feet. All the plates used are of copper, and have inclination of one inch to one foot. The wear of shoes and dies per ton of ore worked is about two pounds. Fifty per cent of the free gold is saved in the battery and fifty per cent on the outside plates. On blankets one per cent of amalgam is saved monthly, and also sulphurets to the amount of one fifth of one per cent of the ore crushed. Loss of quicksilver per ton of ore is estimated at about one half ounce. Concentration is done on blankets, riffles, sluices, and afterwards in a Cornish buddle. The charge for treating the sulphurets, which are sold to the chlorination works, at Sutter Creek, is $20 per ton. The percentage of their assay value allowed to owner is 90. Ore worked from the bottom of shaft and bottom of open cut yielded 66 per cent in the battery and 33 per cent outside.

The motive power of the mill is water. A four and one half-foot Knight's wheel is used, under a pressure of ninety-six feet. Fifty miner's inches are required for battery and power.* The cost of water is 20 cents per miner's inch.

Developments.

These consist of a shaft sixty feet deep and a tunnel two hundred and fifty feet long, tapping an open cut.

It is proposed to sink a permanent working shaft, put in six thousand five hundred feet of pipe, and bring in water, with a pressure of four hundred feet, and increase the size of the mill. This mine was formerly known as the Iowa, and has produced over $76,000. Five stamps of the mill have been running five years, and ten stamps three years. It was incorporated in May, 1888, under California laws, as the Sutter Creek Gold Mining Company.

The total monthly expenses of the Sutter Creek Mine and Mill are as follows: Labor, $600; water, $300; shoes, dies, powder, timber, and incidentals, $100; total, $1,000. Mill crushes monthly four hundred and fifty tons of ore. Cost of mining, milling, and transportation per ton, $2 22. Of this cost: Labor, per ton, at mine, 83 cents; general incidentals, 11 cents; total, 94 cents; transportation, 17 cents. Milling: Labor, per ton, at mill, 33⅓ cents; water for power and battery, 66⅔ cents; screens, 1 cent; shoes and dies†, 8 cents; quicksilver, 2 cents; total, $1 11.

*The water is conveyed to the mill in pipe, eleven inches in diameter, made of No. 16 iron, coal tarred, and riveted, five hundred and fifty feet in length.

† Eight cents, when two tons of ore are crushed per stamp; 11 cents, when one and one half tons are crushed daily. Other items calculated on a crushing of one and one half tons. At times two tons of ore are crushed daily for months, and then the entire cost of mining and milling is $1 66 per ton.

Altitude (aneroid reading)	1,400 feet.
Length of ore shoot	700 feet.
Depth of ore shaft vertically	60 feet.
Vertical depth reached in mine	60 feet.
Quantity of water raised in twenty-four hours	None.
Character of hanging-wall	Diorite.
Character of foot-wall	Diorite.
Kind of powder used	Giant, No. 2.
Quantity of powder used	200 pounds per month.
Cost of mining	94 cents per ton.
Cost of tunnel	$3 per foot.
Number of feet timbered	60
Kind of timber	Round pine.
Cost of timber	$1 50 per stick 16 feet long, 8 inches and 10 inches in diameter.
Cost of transport of ore	Included in mining.
Character of works	Free milling, water power mill.
Number of stamps	10
Weight of stamps	850 pounds.
Drop of stamps	6 inches.
Drops	90 per minute.
Duty of stamp	1½ to 2 tons in twenty-four hours.
Kind of shoes and dies	Iron.
Size and character of screens	No. 8 angle slot.
Water used in battery	2½ miner's inches.
Dimensions of apron	3 by 4 feet.
Width of sluice	14 inches.
Length of sluice	12 feet.
Kind of feeder	Templeton.
Kind of concentrators	Blankets, riffle sluices, and buddle.
Character of ore	Free milling.
Percentage of gold saved in battery	50
Percentage of gold saved on plates	50
Percentage of sulphurets	½
Value of sulphurets	$45 per ton.
Cost of milling	$1 11 per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	2
Number of men in mine	5
Number of men on outside work	1
Total number employed	8
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$2 50 per day.
Quantity of water used in milling	2½ miner's inches.
Head of water used for power	96 feet.
Quantity of water used for power	47½ inches per day.
Cost of water for milling / Cost of water for power	20 cents per inch, $10
Cost of transportation	17 cents.

WILDMAN GOLD MINING COMPANY.

The property of this company is situated in the town of Sutter Creek. The course of the vein is west, 2 degrees west approximately, and the dip north of east, or at an angle of 65 degrees. The width of the vein is about four feet, as far as developed. The dimensions of the claim are thirteen hundred feet in length and six hundred feet in width. There are two ore shoots on the mine. No. 1 has a length of sixty feet on the two hundred-foot level, one hundred and fifty feet on the four hundred-foot level, two hundred and twenty feet on the five hundred-foot level. No. 2 has a length of forty feet at four hundred and fifty feet from the surface, and sixty feet at five hundred feet from the surface. The mine is worked through an incline shaft. The present depth, in September, is six hundred and twenty feet on the incline, corresponding to a vertical depth of five hundred and sixty-five feet. Sinking is still in progress, and it is the intention to sink two hundred or three hundred feet farther before stoping. The walls on either side of the ore shoot are black slate. The quantity of

water coming in is about one hundred thousand gallons in twenty-four hours. Knight's improved Cornish pump, driven by Knight's hydraulic engine, is used. It is a ten-inch pump, with an eight-inch column, and a six-foot stroke and a five hundred-foot lift. Its usual speed is four to five strokes per minute. This pump was employed in removing the water from the mine, when operations were resumed in the shaft, after it had been unused for twenty years or more. The hydraulic engine was secured to the timbers near the top of the shaft, in the pump compartment, and the pump lowered from time to time. Below the five hundred-foot level, another Cornish pump, eight-inch cylinder, is used in sinking, driven by Knight's hydraulic engine, and raises water to the five hundred-foot level. Giant powder, No. 2, is used, at the rate of two hundred pounds per month. Three hundred and fifty pounds of Black Diamond steel are used monthly. The cost of mining is about $3 per ton, exclusive of shaft sinking. The cost of running levels is given at $5 per foot, and the number of feet run per week, with four men, is given at eighteen feet on the average. The shaft and levels are timbered throughout with round pine timber. The following prices are paid for the timber: Poles, 75 cents each; six inches diameter at smaller end, $1; seven inches diameter, $1 12½; eight inches, $1 30; nine inches, $1 50; ten inches, $1 75; eleven inches, $1 87; twelve inches, $2; thirteen inches, $2 50; fourteen inches, $2 75; fifteen inches, $3 25; sixteen inches, $4. These prices are for timbers barked, and having a length of sixteen feet. The distance of timber from the mine is from twenty to twenty-two miles.

The company has put in four thousand feet of pipe, conveying water to the mine under a head of four hundred and sixty-two feet and four hundred and seventy-four feet to the mile, the pressure gauge indicating at the mill two hundred pounds pressure to the square inch.* There were required two thousand feet of pipe, thirteen inches in diameter, No. 12 iron; one thousand feet, eleven inches in diameter, No. 14 iron; and one thousand feet, eleven inches in diameter, No. 16 iron. The mill is conveniently situated near the mouth of the shaft; thus transportation cost is avoided. The rock is mostly what is termed ribboned, is easily crushed, and contains from 1 to 2 per cent of sulphurets. The ore is crushed by stamps, amalgamated in the battery and on outside plates, and the sulphurets concentrated on Frue vanners. The hoisting works consist of a water power single friction hoist, having a capacity of raising one hundred tons per day from one thousand feet in depth, driven by a Knight's six-foot wheel, a Sturtevant blower, and a Knight's hydraulic pump combination. The gallows frame is eighty feet high. The mill is a ten-stamp Knight's pattern, with seven hundred and fifty-pound stamps, contains a Blake's rock breaker, ten by twelve-inch, four Frue concentrators, and an electric plant for lighting both hoisting works and mill.

The Electric Plant.

The electric plant consists of one thirty-lamp dynamo, driven by a Knight's twelve-inch wheel, under about two hundred pounds pressure per square inch. Five Edison incandescent lights, of twenty-five candle power each, are used at the mine, and nine lights at the mill. The wheel requires one inch of water, under the above pressure, or about seventeen thousand gallons of water per day, on the average, in order to run the dynamo during that portion of the twenty-four hours when artificial light

*This would show a loss of about 5⅜ pounds per square inch for friction.

is needed, provided that all of the fourteen incandescent lights are in use at one time. The daily cost of fourteen incandescent lights, of twenty-five candle power each, at the Wildman Mine, is as follows: Water, one miner's inch at 20 cents, 20 cents; breakage, average for first three months, 5 cents; replacing parts, average for first three months, 5 cents; total, 30 cents. The plant gives entire satisfaction; requires no skilled labor or attention. The lights can be turned off from the works at the mine or mill, independent of each other. The cost of this entire plant erected was $350. Manufactured by the firm supplying electric plant for the South Spring Hill.

Chrome steel is used for shoes and dies, and costs about 9½ cents per pound, delivered in carload lots. The steel has not been used long enough to make a comparison with the iron. It has an advantage in not requiring change so often. When iron was used for shoes and dies, on an average one thousand four hundred tons of ore wore out one thousand five hundred and fifty-one pounds of shoes and one thousand three hundred and two pounds of dies, or two thousand eight hundred and fifty-three pounds of shoes and dies, less seven hundred and thirteen pounds returned, at 2 cents; $114 12 less $42 80 equals $71 32. This gave the wear of shoes and dies per ton of ore crushed, 5 cents—equivalent to a net loss of one and one fourth pounds of iron per ton of ore. The quantity of water used in the battery is estimated at three inches per day. The screens used are No. 7 angle slot, having dimensions inside the frame of seven by forty-eight inches, and are slightly inclined. The size of the apron is two by four feet. Below the apron a double sluice is used, fourteen inches in width; the length of sluice to each battery is fifteen feet. Copper plates are used inside the battery, silvered plates on aprons and sluices. The inclination of plates to the foot is one inch to one and one fourth inches. The percentage of recovery in the battery in free gold is about 66 per cent, and on plates outside about 33 per cent. Percentage of sulphurets is one to two, principally iron pyrites, in value varying from $78 per ton to $125. Fineness of gold, 800. The concentrations are sold to the Amador Reduction Works. The charge for treatment is $20 per ton, and 90 per cent of the assay is allowed.

One six-foot Knight's wheel is used to run the hoisting works, and one of the same size drives the main machinery of the mill, while a thirty-inch one drives the rock breaker, a twelve-inch one the dynamo, and a ten-inch one the grindstone. The Sturtevant blower is run by a Donnelly wheel. The pump requires ten inches of water while running from the five hundred station.* Ten miner's inches of water, under four hundred and sixty-two feet of head, removed seventy-five thousand to one hundred thousand gallons per day from five hundred feet in depth, at a cost of $2 for power. A seven eighths inch flexible steel wire rope is used. Forty-two inches of water are used at the mine and mill, at 20 cents per inch. Eight dollars and forty cents will cover the expense of all water required by the company. Twenty-two inches of water are used by the mill and battery, and twenty by hoisting works.

Developments.

Incline shaft, depth	620 feet.
150 feet level, length	80 feet.
300 feet level, length	180 feet.
400 feet level, length	260 feet.
500 feet level, length	460 feet.

*The main pump is driven by an hydraulic engine, situated at the top of the shaft, said engine requiring ten miner's inches of water when the pump station is at the five hundred level. Additional power, or equivalent in miner's inches, of course, is required to run the sinking pump below the five hundred level.

The mine has been idle about twenty years, but during the past year the water has been taken out of the mine. The shaft has been put in order and retimbered. A Knight's hydraulic pump has been procured. All the old levels have been repaired. Two hundred and thirty feet have been run on the five hundred-foot level, one hundred feet on the four hundred-foot level, and seventy-five feet on the three hundred-foot level. An excellent ten-stamp mill has been erected, complete with Frue concentrators. Connection has been made with the canal of the Blue Lakes Water Company, and an electric plant for lighting purposes introduced. Entirely new hoisting works have been erected. It is proposed to put in ten additional stamps with new concentrators; to sink the incline two hundred feet deeper, and run two new levels on the mine.

Milling: Water cost per ton of ore, 18 cents; labor cost per ton of ore, 26 cents; shoes and dies, 5 cents; electric lighting, 1 cent; screens, 1 cent; quicksilver, 1 cent; other incidentals, 8 cents; total, 60 cents.

Altitude (aneroid reading)	1,180 feet.
Length of ore shoot (two shoots)	1— 60 feet. 1—220 feet.
Length of ore shaft on incline	620 feet.
Depth of ore shaft vertically	565 feet.
Vertical depth reached in mine	565 feet.
Vertical depth of water shaft	565 feet.
Quantity of water raised in twenty-four hours	75,000 to 100,000 gallons.
Character of hanging-wall	Rock adjoining ore shoot, slate.
Character of foot-wall	Rock adjoining ore shoot, slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used	200 pounds per month.
Cost of mining	$3 per ton.
Number of feet timbered	620
Kind of timber	Round timber.
Cost of timber	According to size, from 75 cents to $4
Character of ore	Ribbon rock, soft, free milling, with sulphurets.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamps	5 to 6 inches.
Drops	90 per minute.
Duty of stamp	2¼ tons in twenty-four hours.
Kind of shoes and dies	At present, chrome steel.
Size and character of screens	Angle slot, No. 7.
Water used in battery	Estimated 3 inches.
Dimensions of apron	2 by 4 feet.
Width of sluice	14 inches.
Length of sluice	15 feet.
Kind of feeder	Hendy's Challenge.
Kind of concentrators	Frue's.
Number of concentrators	4
Character of ore	Free milling.
Percentage of gold saved in battery	66
Percentage of gold saved on plates	33
Percentage of sulphurets	1 to 2
Value of sulphurets	$78 to $125 per ton.
Cost of milling	60 cents per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	2
Number of men in mine	18
Number of men on outside work	5
Total number employed	25
Average wages in mine	$2 50 to $3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$1 50 to $2 50 per day.
Quantity of water used in milling	Estimated 3 inches.
Head of water used for power	To mine, 462 feet. To mill, 474 feet.
Quantity of water used for power and milling	42 inches.
Cost of water for milling	Battery, 60 cents per day.
Cost of water for power	Power for milling $3 88 Power for electric light 20 Power for pump 2 00 Power for hoisting 1 80
Total water per day	42 inches, at 20 cents, $8 40

THE ONEIDA.

At the Oneida Mine ten stamps have been kept busy for the last two years running on the old gouge pile. This mine is situated on the mother lode between Jackson and Sutter Creek, and had good ore in the bottom when work was suspended. It was formerly one of the famous mines of the lode, but the bad ground and the large quantity of water coming in made it, in those days, very expensive to work. The mine for years supplied a sixty-stamp mill.

LIVE OAK.

This mine is in the Jackson District, situated about one and one half miles southwest of Jackson. It was one of the early quartz locations made in the county. The course of the vein is northeast and southwest. It dips to the southeast for the first forty feet nearly vertically, after that depth about 50 degrees. The average width is from one to two feet. The dimensions of the claim are nine hundred by six hundred feet. There are two ore shoots on the mine, separated by about ten feet of barren ground; one shoot is one hundred and ten feet in length. The length of the other has not yet been determined. The mine is worked by a shaft nearly vertical for forty feet; the last one hundred and thirty-five feet, however, are at an angle of about 50 degrees. The depth, measured on the incline, is one hundred and seventy-five feet, reaching a vertical depth in the mine of one hundred and fifty feet. Hanging and foot-walls are the same, diorite (greenstone). The mine is kept free of water by means of a three-inch "Jackhead" pump, with two-inch column, and two and one half-inch stroke, running one third of the time. Work is done with single hand drills. Hercules powder, No. 2, is employed; of this about thirty-five pounds are used per month. The cost per foot in running levels is from \$5 to \$6. The number of feet run per day is about two and one half.

No record was kept of the cost of sinking the shaft, nor of the number of feet sunk per day. The formation passed through was vein matter. The shaft and levels are timbered. Sawed spruce is used in timbering, costing \$22 50 per thousand. The mine is distant about twenty-two miles from timber. The company has built one mile of ditch.

The ore is crushed, and amalgamated in the battery and on outside plates; the mill contains a battery of two stamps, weighing eight hundred and fifty pounds each, driven by a Donnelly wheel, four feet in diameter. The cost of shoes and dies per pound, 4 cents. The wear of shoes and dies per ton crushed is about 6½ cents. The quantity of water used in the battery is estimated at one half miner's inch per day (twenty-four hours). Battery screens are placed nearly vertical, and are angle slot, No. 6, with dimensions inside the frame nine inches by eighteen inches; the discharge height of bottom of screen above the die, when first placed in mortar, is six inches. The percentage of value saved in the battery is about 66 per cent; on the plates is about 33 per cent.

The hoisting works and mill are both run by water power from the same wheel—a four-foot Donnelly. Twenty-five inches of water are bought from the Blue Lakes Water Company, at a cost of 20 cents per inch.

Developments.

Shaft, 175 feet deep.
First level, 40 feet deep; drifted on 40 feet, not stoped.
Second level, 100 feet deep; drifted on 120 feet north, 40 feet south.
Third level, 170 feet deep; drifted on 170 feet north.

Developments made during the year were seventy feet of shaft and one hundred and ten feet of drift on the lower level.

The pump is run from the mill by power, transmitted at right angles from the cam shaft; when the pump alone is running a five eighths inch nozzle is required; for mill and pump running together, two nozzles—a one and a one and five eighths nozzle—are used. The walls of the mine are two and one half feet to five feet from each other; the fissure is filled by ore and a hard gouge.

Altitude (indicated by aneroid)	1,250 feet.
Length of ore shoot	110 feet.
Length of ore shaft on incline	175 feet.
Depth of ore shaft vertically	150 feet.
Vertical depth reached in mine	150 feet.
Quantity of water raised in twenty-four hours	About 15,000 gallons.
Character of hanging-wall	Diorite.
Character of foot-wall	Diorite.
Kind of powder used	Hercules, No. 2.
Quantity of powder used	35 pounds monthly.
Cost of mining	$3 per ton.
Cost of tunnel	$5 to $6 per foot.
Cost per foot of shaft	No record kept.
Number of feet timbered	175
Kind of timber	Sawed pine and spruce.
Cost of timber	$22 50 per thousand.
Length of ditch built	One mile.
Cost of transport of ore	Nothing.
Character of ore	Free milling.
Character of works	Water power, free milling.
Number of stamps	2
Weight of stamps	850 pounds.
Drop of stamps	5½ to 6 inches.
Drops	93 per minute.
Duty of stamp	2½ to 3 tons in twenty-four hours.
Kind of shoes and dies	Iron.
Size and character of screens	No. 6 angle slot.
Water used in battery	½ inch.
Dimensions of apron	2 feet by 3 feet.
Width of sluice	14 inches.
Length of sluice	16 feet.
Kind of feeder	Home-made.
Percentage of gold saved in battery	66
Percentage of gold saved on plates	33
Percentage of sulphurets	Not determined.
Value of sulphurets per ton	Not determined.
Cost of milling	$1 65 per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	2
Number of men in mine	4
Total number employed	6
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Quantity of water used in milling	½ inch.
Head of water used for power	85 feet.
Quantity of water used for power	25 inches.
Cost of water for milling and for power	$5 per day.

SOUTH SPRING HILL.

This mine was located more than twenty-five years ago, but was taken hold of by the present company in 1882. It is incorporated under the laws of the State of Maine. This property is situated in the Amador Mining District, one half mile southeast of Amador City, and a little less than two miles northwest of Sutter Creek. The course of the vein is northwest and southeast, with a dip northeast, varying from 52 degrees to 85 degrees, and a width of about twenty feet, though in its widest place it reaches fifty feet. The dimensions of the claim are six hundred feet in width and one

thousand eight hundred feet in length. The length of the ore shoot is about seven hundred and sixty feet. The shaft, an incline, is eight hundred feet deep, corresponding to a vertical depth of seven hundred and fifty-eight feet. The ore shoot has a diorite hanging-wall, formerly termed greenstone, black slate with a gouge on the foot. The mine produces about ten thousand gallons of water per day, which is raised to the surface by a Dows No. 2 steam pump, having a one and one half-inch column, a speed of one hundred strokes per minute, running on an average one half the time; besides a sump, five by nine, and twenty-five feet deep, is emptied once each week. A Rix double ten-inch cylinder compressor forces the air one and one half miles and furnishes the power to run three National drills. The compressor and entire outfit, together with two drills, cost on the ground, $1,350.

About two thousand pounds of different kinds of nitro-glycerine powder and one hundred pounds of steel are used monthly.

The cost of mining for the last year was $2 50, but it is now some less. The cost of running the levels has not been kept separate. The number of feet run per day has been very variable. The labor cost of sinking the shaft was from $11 to $15 per foot, the additional expense for material being about $10.* On the last sinking in the shaft one foot per day was made; the one hundred feet preceding requiring fifty-five days. The formation passed through was black slate and gouge. The shaft is timbered throughout with round and square spruce.

Cost of Timbers.

Lumber, per thousand	$20 00
Lagging, five and six feet long. (Split lagging pine or spruce averages, each piece, two by six inches.) Per thousand	$65 00 and 75 00
Poles under six inches diameter at smaller end, sixteen feet long, each	50
Poles six inches diameter at smaller end, sixteen feet long, each	75
Poles seven inches diameter at smaller end, sixteen feet long, each	90
Logs eight inches diameter at smaller end, sixteen feet long, each	1 00
Logs nine inches diameter at smaller end, sixteen feet long, each	1 25
Logs ten inches diameter at smaller end, sixteen feet long, each	1 40
Logs eleven inches diameter at smaller end, sixteen feet long, each	1 75
Logs twelve inches diameter at smaller end, sixteen feet long, each	1 85
Logs thirteen inches diameter at smaller end, sixteen feet long, each	2 25
Logs fourteen inches diameter at smaller end, sixteen feet long, each	2 50
Logs fifteen inches diameter at smaller end, sixteen feet long, each	3 00
Logs sixteen inches diameter at smaller end, sixteen feet long, each	3 50
Logs seventeen and eighteen inches diameter at smaller end, sixteen feet long, each	4 00
Logs nineteen inches diameter at smaller end, sixteen feet long, each	4 25
Logs twenty inches diameter at smaller end, sixteen feet long, each	4 40

For spruce timber up to twelve inches in diameter the same prices are paid as for pine. Logs of spruce timber, sixteen feet long, are purchased at the following prices: Logs 13-inch diameter at smaller end, each $3; 14-inch diameter at smaller end, each $3 50; 15 and 16-inch diameter at smaller end, each $4 50. Distance of mine from timber, twenty miles.

The ore is transported from the mine, at a cost of 10 cents per ton, on cars over a tramway having a gauge of thirty-two inches and supplied with T rails, of steel weighing sixteen pounds to the yard. The ore is passed through an eight by twelve-inch Blake rock breaker, thence to self-feeders which feed it to the stamps. Amalgamation is done in the battery and on outside plates. The sulphurets are saved on the Frue and Triumph vanners, and the tailings therefrom, under lease, passed over canvas, the lessee paying 15 or 20 per cent of the gross yield. The concentrations are worked at the Amador Reduction Works at Sutter Creek.

*The size of the shaft is eight by four and a half feet in the clear. The shaft is usually lagged in the hanging-wall side—seldom in the ends.

The hoisting works are at present run by steam power, furnished by a boiler fifty-four inches in diameter and sixteen feet long, and an eight by twelve-inch double engine. The mill, which is run by water power, has a six-foot Knight wheel, driving the main works, and a three-foot Knight wheel, driving the rock-breaker. The pressure gauge indicates one hundred and twenty-eight pounds* at the wheel. An eight-inch Knight wheel drives the dynamo, generating electricity for lighting the mill and hoisting works. One twenty-six-inch Knight wheel drives the blower, and one of the same size is used for running the grindstone. The mill, with seven-inch discharge batteries, contains thirty stamps of seven hundred and fifty pounds each, ten Frue and two Triumph concentrators.

Stamps.

Brooklyn chrome steel is used for shoes and dies. The order of the drop of the stamps: $\left(\begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \\ \oplus & \oplus & \oplus & \oplus & \oplus \\ \text{1st.} & \text{3d.} & \text{5th.} & \text{4th.} & \text{2d.} \end{array}\right)$. The order of the drop is given in this place, as it has something to do with the even wear of the shoes and dies. The cost of chrome steel delivered in Ione is $9\frac{1}{3}$ cents per pound, and the freight is one fourth cent additional to the South Spring Hill Mine.

One set of chrome steel shoes with dies, weighing eight thousand five hundred and fifty-nine pounds, as stated by the Superintendent, have lasted from four to five months, and have crushed ten thousand tons of South Spring Hill ore. Eight thousand five hundred and fifty-nine pounds steel, at $9\frac{7}{12}$ cents, equals $820 34 to ten thousand tons ore. Eighty-five and fifty-nine one hundredths pounds steel, at $9\frac{7}{12}$ cents, equals $0.082+ to one ton ore. There is no sale to local foundries for old steel. The screens used in the mill are angle slot, Nos. 7 and 8, costing $18 per set, and lasting one month. On the average two thousand two hundred and fifty tons of ore wear out $18 worth of screens. In other words, the cost of the screens per ton of ore crushed is about $\frac{8}{10}$ cent when working on South Spring Hill ore. The water used in the battery is estimated at about ten miner's inches per day. The mortar used is Knight's pattern. The screens are slightly inclined, and have dimensions inside of the frame of nine by forty-five inches.

Plates.

The size of the apron is twenty-four by forty-eight inches, and the width of the sluices is fifteen inches. The length of the sluice to each battery is eighteen feet. The size of the plates inside of the battery is six by forty-eight inches, three sizes being used to adapt the weight of discharge to the wear of the dies. The plates are silvered and have an inclination of one and one third inches to one foot.

Of the recovery, about 60 per cent is saved in the battery, and about 40 per cent on the outside plates. From forty to seventy-five tons of concentrations per month are saved. The loss of quicksilver is about four hundred ounces per month, or a little less than $\frac{18}{100}$ ounce per ton of ore worked, or about $\frac{3}{4}$ cent in value per ton of ore worked. The concentrations are sometimes sold to the chlorination works, and sometimes are worked by them on stipulated terms. The charge for reduction is $20 per ton, and the percentage of the assay value allowed is 92. One and one fourth cords of wood are used daily for steam purposes, at a cost of from $5 to $6 per cord. The company pays for ninety-three inches of water, at 20 cents per

* About six pounds to the square inch more than would appear were there no friction.

inch, or $18 60 per day for power, milling, etc., and in addition to this $100 per month extra for power to run the compressor, and twenty drills if desired, under contract for fifteen years. About one and one fourth miles from the mine there is a fall of one hundred and twenty-five feet in the canal of the Blue Lakes Water Company, which is utilized by the South Spring Hill Company. At this point are the compressors, and two receivers with safety valves set for eighty pounds pressure, and compressor building, and thence a pipe about one and one fourth miles long conveys the compressed air to the bottom of the mine. There are three thousand four hundred feet of four-inch pipe, two thousand two hundred feet of two and one half-inch pipe, and balance two-inch pipe, reaching to the bottom of the mine, then one-inch pipe is used.

The rock breaker takes fifteen inches of water, at two hundred and seventy feet pressure. The blower takes one half inch of water, at two hundred and sixty-five feet pressure. The dynamo takes six inches of water on eight-inch wheel, at two hundred and seventy feet pressure, but this is not paid for extra, as the water that runs it is used in the battery afterwards, and would be required any way. This dynamo supplies twenty-seven lights of twenty-five candle power each. In this case the power for electric lights costs nothing. The expense connected with electric lighting, for one and one half years, has been about $50, or $2 78 per month, or a little over 9 cents per day. The greater part of this expense has arisen from inexperience—breakage of the incandescent lamps by starting the dynamo too fast. The cost of the plant was $350, manufactured by J. E. Bowers, Fitchburg, Massachusetts.

Developments.

Incline shaft, 800 feet deep.
First level, 500 feet from surface, 100 feet long.
Second level, 600 feet from surface, 755 feet long.
Third level, 700 feet from surface, 640 feet long.
Fourth level, 800 feet from surface, 400 feet long.
Sump, 25 feet deep.

There is an uprise from the five hundred-foot level four hundred and thirty feet, connecting with an adit level to the surface, giving ventilation to the mine, and means of escape to the miners, in case of accident.

Indications of ore were found in the shaft, but no ore was found in paying quantities until a depth of five hundred feet was reached in the mine. It is intended to erect new hoisting works, and provide both water and steam power, independent of each other, and to put in the mill the largest size of Blake's rock breaker, and sink a shaft.

The milling cost may be segregated as follows: Labor, per ton, 18 cents; shoes and dies, 8 cents; lights and screens, 1 cent; water, 25 cents; quicksilver, 1 cent; incidentals, proportion office expenses, etc., 12 cents; total, per ton, 65 cents.

Altitude (aneroid reading)	1,100 feet.
Length of ore shoot	755 feet.
Length of ore shaft on incline	800 feet.
Depth of ore shaft vertically	758 feet.
Vertical depth reached in mine	783 feet.
Quantity of water raised in twenty-four hours	10,000 gallons.
Character of hanging-wall	Diorite.
Character of foot-wall	Slate.
Kind of powder used	Nitro-glycerine.
Quantity of powder used	2,000 pounds per month.
Cost of mining	$2 50 per ton.
Cost of tunnel	$2 to $4 per foot.

Cost of shaft	$25 per foot.
Number of feet timbered	All.
Kind of timber	Spruce.
Cost of timber (sawed)	$20 per thousand.
Length of road built	One half mile.
Cost of transportation of ore	10 cents per ton.
Character of ore	Free milling, with sulphurets.
Number of stamps	30
Weight of stamps	750 pounds.
Drop of stamps	6 to 7 inches.
Drops	90 to 93 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	Brooklyn chrome steel.
Size and character of screens	Angle slot, Nos. 7 and 8.
Water used in battery (estimated)	10 inches.
Dimensions of apron	2 by 4 feet.
Width of sluice	15 inches.
Length of sluice	18 feet.
Kind of feeder	Hendy's Challenge.
Kind of concentrators	10 Frue's and 2 Triumph.
Character of ore	Slate and quartz, friable.
Percentage of gold saved in battery	60
Percentage of gold saved on plates	40
Percentage of sulphurets	2
Value of sulphurets	$100 per ton.
Cost of milling	65 cents per ton.
Cost of working suphurets	$20 per ton.
Percentage of value extracted from sulphurets	92 per cent.
Number of men in mill	5
Number of men in mine	45
Number of men on outside work	10
Total number employed	60
Average wages in mine	$2 50 to $3 per day.
Average wages in mill per day	$2 50 to $3 per day.
Average wages paid outside	$2 to $2 25 per day.
Wood used per day	2½ cords.
Cost of wood	$5 to $6 per cord.
Quantity of water used in milling	10 inches.
Head of water used for power (by survey)	308 feet.
Water used for power	83 miner's inches.
Cost of water for milling	10 inches at 20 cents, $2
Cost of water for power	83 inches at 20 cents, $16 60

MOORE MINE.

The mine is situated near the town of Jackson, in the Jackson Mining District, and at an altitude of one thousand five hundred feet above the level of the sea. The course of the vein is southeasterly and northwesterly, with an easterly dip of 52 degrees. The claim is three thousand two hundred feet long by one thousand four hundred feet wide; length of shoot, one thousand two hundred feet; average width of vein, sixteen feet; and explored depth, five hundred feet. The hanging-wall is greenstone, and the foot-wall black slate. The ore, containing about 2 per cent of sulphurets, is what is termed free milling. The developments are: Shaft, four hundred feet deep; three levels, varying in length from two hundred to four hundred feet, and a fourth level now being opened. The present explorations show an ore body sixteen feet wide. The amalgamation is conducted in the batteries and by collection on outside plates. The sulphurets (iron pyrites) are recovered by concentration in buddles and worked for gold by the chlorination process at a cost of $15 per ton. The mill, run by water power, contains ten stamps, weighing eight hundred and fifty pounds each, with a seven-inch drop, falling ninety times per minute, and crushes three tons per stamp every twenty-four hours. The plates, silver plated, are forty-eight inches wide and twenty feet in length to each battery. The hoisting works are run by steam.

Altitude	1,500 feet.
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamps	7 inches.
Drop of stamps	90 per minute.
Duty of stamp	3 tons in twenty-four hours.
Size of screens	6 slot.
Water used in mill every twenty-four hours	100 miner's inches.
Pressure of water	110 feet.
Cost of mining	$1 75 per ton.
Cost of milling	$0 80 per ton.
Percentage of recovery saved in batteries	50
Percentage of recovery saved on plates	35
Percentage of sulphurets	2
Value of sulphurets	$130 per ton.
Cost of working sulphurets	$20 per ton.
Number of men in mine	15
Number of men in mill	4
Length of ore shoot	1,200 feet.
Average width of vein	10 feet.
Depth of shaft	400 feet.

There have been no new developments on this property during the past year. The results of milling the ore are said to have been entirely satisfactory.

ZEILE MINE.

This mine is situated about one fourth of a mile south of Jackson, in Jackson District. The general course of the vein is north, 27 degrees west; the dip is north, 63 degrees east, at an angle of about 55 degrees with the horizon. The Zeile Mine, formerly known as the Coney, is one of the oldest locations in the district. The dimensions of the claim are one thousand six hundred by five hundred feet, and additional ground to the extent of twenty acres. The width of the vein is about thirty feet. The length of the ore shoot is four hundred feet, with some intervening poor spots. The mine is opened by two inclined shafts. The main shaft is eight hundred and eighty-five feet deep, the air shaft two hundred and seventy-one feet, corresponding to vertical depths of seven hundred and twenty-five feet and two hundred and twenty feet, respectively. The walls are of slate, with gouge on the footwall, from a few feet to fifty-five feet in width. During the summer months the mine yields fifteen thousand gallons of water daily, and in winter from fifteen thousand to fifty thousand gallons. No pumps are used, but in their stead tanks of four hundred gallons capacity, self-filling and self-discharging, running on wheels, are employed in keeping out the water. A duplex, Reynolds and Rix, double cylinder compressor, and the Ingersoll and National drills are in use. Nitro-glycerine powder, containing 35 per cent nitro-glycerine, is consumed at the rate of one ton every thirty days. The labor cost of sinking the shaft was about $15 per foot. The shafts pass through vein matter, and the timber mostly used, about twenty inches in diameter, is spruce where dry, and sugar pine and yellow pine where constantly wet. Sawed timber costs $20 per thousand feet; round pine, sixteen feet long, fourteen, fifteen, and sixteen inches in diameter, $3 each; seventeen and eighteen inches, $3 50; nineteen and twenty inches, $4; twenty-four inches is $5—all of which is carried a distance of twenty miles. The ore is hauled over a tramway from the mine to the mill by the "bucket lander" at the hoisting works, at the cost of 50 cents per day. The ore is quartz and slate, with a small amount of free gold, and yields about 2¼ per cent of very pure iron sulphurets.

A large rock breaker at the hoisting works receives and crushes the ore as fast as it is raised from the mine, and the ore goes to the mill crushed fine enough for the stamps, without having had an attendant at the rock

breaker. The amalgamation is done in the battery and on the outside plates. The sulphurets, obtained by concentration, are chlorinated by the Plattner process, in works belonging to the company, which have a capacity for treating three tons in twenty-four hours. The mill is arranged for both steam and water power. When steam is used, which is only in case of a failure of a water supply, two boilers, fifty-four inches in diameter by sixteen feet long, and a sixteen-inch cylinder engine, Corliss pattern, are employed, and the power is transmitted to the main shaft by five one and three-fourths-inch diameter manilla ropes, running over groove pulleys. When running by water, a six-foot Pelton wheel, with a rubber adjustable nozzle, under one hundred and forty-five feet pressure, drives the mill, compressor, and blower; and the power is transmitted by a five-ply rubber belt of suitable width. The rubber adjustable nozzle has been in use nearly two years, and works to entire satisfaction. It is made of perfectly smooth medium rubber, and shows less wear than iron nozzles which have been in use for the same length of time; the same nozzle, under the same pressure, can be used in running any number of stamps, from five to forty, by turning a screw, which compresses the rubber endwise and enlarges or diminishes the opening. Chrome steel is now used for shoes and dies, and the company pays per pound, according to wear. The quantity of water used in the battery and concentrators has never been measured, but is estimated at twenty miner's inches in twenty-four hours. Screens No. 4, straight, one half inch slot, made of No. 12 Russia iron, placed vertically, are used, with dimensions, inside of the frame, six inches by fifty inches.

Plates.

The size of the aprons is fifty-eight inches by thirty inches; the width of the sluices is sixteen inches; the length is twelve feet; the inclination of the apron is two and one eighth inches; of the sluice, one and one fourth inches to one foot. One third of the total recovery of the ore value is saved on the inside and outside plates as free gold, and two thirds on the concentrators as sulphurets.

There are sixteen Frue concentrators operating in the mill, which use, by estimate, five miner's inches of water daily. The gold caught in the mill is worth about $17 75 per ounce; that recovered in the chlorination works is generally 998 fine. The chlorination works are provided with every appliance for successfully working sulphurets by the method the name implies. The roasting furnace, with a capacity for treating three tons of sulphurets in twenty-four hours, is seven feet high, eleven feet wide, and sixty-six feet long, outside measurement, with a dust chamber six by six feet square; a stack five by five feet square at the base, and three by six feet at the top, forty feet high. The furnace inside has three hearths, with two drops of six inches each. It is lined inside with fire-brick, and shaped so that the charge may be easily rubbed. The consumption of wood is one and three tenths cords per day in summer, and one and three eighths cords in winter. About one ton of sulphurets, mixed with five pounds of salt, is charged every eight hours. A charge is drawn about every eight hours, making about three tons worked per day. A specimen charge for gassing Zeile sulphurets is given as follows: For four and one half tons of sulphurets, sixty pounds manganese per oxide; sixty pounds salt; one hundred pounds sulphuric acid, 66 degrees.

After the gassed pulp has been leached a further addition of a few pounds of sulphuric acid is added to remove perceptible bases. The object of removing these bases is to give a cleaner or purer gold product. The base

most commonly precipitated is lead, as sulphate of lead; if present and not precipitated by sulphuric acid, it would be precipitated when sulphate of iron is added to precipitate the gold, thus contaminating it. Some sulphate of lime is precipitated also, and other bases mechanically go down with sulphate of lead in small quantities. By this treatment the gold product is purer and less protosulphate of iron is used. The liquid is run off into the precipitating tanks and the gold precipitated with sulphate of iron in the usual manner.

There are employed in and about the premises, exclusive of the superintendent, one hundred and seven men in the following manner: Eighty-five men and two foremen in the mine, four men and one foreman in the mill, thirteen men on outside work, and five men in the chlorination works. The average wages paid are $2 50 per day for miners; $2 and $2 25 for ore assorters and car men; $2 75 to $3 for timber men; engineers, $3 50 and $2 50, and for carpenters $3 50. Four cords of wood per day are used for steam purposes, and one and three tenths to one and three eighths cords for roasting sulphurets. First class wood costs $5 50 per cord; oak or pine—white oak, $5; black oak, $6; pine, from $3 to $5. Big yellow pine split, such as is used in the roaster, costs $5 50 per cord. Steam gearing at the hoisting works consists of two double engines, Corliss pattern, twelve-inch cylinder, two boilers fifty-four-inch by sixteen feet long, connected or single; reels five feet in diameter; round cable one and one eighth-inch flexible steel, which lasts about one year, is used. Water machinery at the hoisting works consists of a Pelton four-foot wheel under about one hundred feet pressure running the sawmill and framing machine. Water is purchased of the Blue Lakes Water Company on private contract.

Developments.

Two shafts, 271 and 885 feet deep, on the incline.
One level at 140 feet, 745 feet long.
One level at 240 feet, 900 feet long.
One level at 400 feet, 775 feet long.
One level at 500 feet, 622 feet long.
One level at 600 feet, 615 feet long.
One level at 700 feet, 782 feet long.
One level at 800 feet, 640 feet long.

Eighty-five feet of the main shaft is used for a sump. In the two hundred and seventy-one-foot shaft, the developments consist of two levels at one hundred and forty and two hundred and forty feet, run to connect with the main shaft and with winzes to the eight hundred-foot level. Sinking the main shaft is now in progress.

Altitude (aneroid reading)	1,300 feet.
Length of ore shoot	400 feet.
Length of ore shaft on incline	885 feet.
Depth of ore shaft vertically	725 feet.
Vertical depth reached in mine	725 feet.
Vertical depth of water shaft	220 feet.
Quantity of water raised in twenty-four hours	15,000 to 50,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Nitro-glycerine, 35 per cent.
Quantity of powder used	2,000 pounds per month.
Number of feet timbered	All.
Kind of timber	Spruce and pine.
Cost of timber	Sawed, $20 per M.; round, per log, from 75 cents to $5
Cost of transport of ore	$15 per month.
Character of ore	Quartz and slate.
Character of works	Free milling, concentrating, and chlorination.
Number of stamps	40
Order of drop of stamps	1, 5, 2, 4, 3
Weight of stamps	750 pounds.

Drop of stamps	7½ inches.
Drops	87 to 88 per minute.
Duty of stamp	3¼ tons in twenty-four hours.
(Crushed in 1887, including all stoppages, 49,166 tons, with 40 stamps.)	
Kind of shoes and dies	Chrome steel.
Size and character of screens	No. 4 straight slot, ½ inch, made of No. 12 Russian iron.
Water used in battery	15 miner's inches.
Height of discharge	7 inches.
Dimensions of apron	30 by 58 inches.
Width of sluice	16 inches.
Length of sluice	144 inches.
Kind of feeder	Hendy's Challenge.
Kind of concentrators	Frue vanners.
Character of ore	Free milling, with 2¼ per cent sulphurets.
Percentage of gold saved in battery and on plates	33
Percentage of sulphurets	2¼
Value of sulphurets	$100 per ton.
Kind of roasting furnace	Reverberatory.
Number of roasting furnaces	1
Percentage of salt used in roasting	¼
Wood consumed in roasting—per ton of sulphurets	$\frac{45}{100}$ cord.
Number of men in mill	4, and 1 foreman who attends to other duties.
Number of men in mine	85 and 2 foremen.
Total number employed	107 and 3 foremen.
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$2 25 to $2 per day.
Wood used	$5\frac{3}{10}$ to $5\frac{3}{8}$ cords per day.
Cost of wood, average	$5 per cord.
Quantity of water used in milling	20 inches.

THE AMADOR GOLD MINE.

This mine, formerly known as the McKay, is situated in the Jackson Mining District, one and one fourth miles south of Jackson. The course of the vein is north, 30 degrees west. The vein dips 60 degrees east of north, at an angle of about 60 degrees from horizontal. The average width is from twenty to forty feet. The dimensions of the claim are one thousand three hundred and twenty feet wide by about three thousand feet long. The length of the ore shoot is six hundred feet, as far as known, but is supposed to run the full length of the mine. The mine is opened by a tunnel one hundred feet in length, which attains a vertical depth of sixty feet, and by three shafts, two hundred and eighty, two hundred and fifty, and ninety-two feet, respectively. The vertical depth reached in the mine is about two hundred and fifty feet. The hanging wall is what has been termed, on the mother lode, greenstone, but later authorities pronounce it diorite. The foot-wall is the peculiar black slate of the mother lode. The mine yields about sixty thousand gallons per day of water, which is removed by a six-inch Garrett "jack head" pump. The National compressor and the National drill are used, and six hundred pounds monthly of Hercules powder, No. 2. About ten feet a week are made in the tunnel, at a cost of $6 per foot. The cost of sinking the shaft, eight and one half by four and one half feet, in the clear, has been about $30 per foot; the progress has been from eight to nine feet per week. Slate and quartz was the formation passed through. All the shafts are timbered, and double compartment from top to bottom. Sawed timber, spruce and pine, is used in the shafts, eight by eight inches and twelve by twelve inches, at a cost of $20 50 per thousand. Round timbers, sixteen feet long, cost 75 cents to $4 each, according to the diameter at the smaller end. All of the mines along the lode are from sixteen to twenty-five miles from timber. The ore will be conveyed by a tramway, two thousand two hundred feet long, from the mine to the new mill now being built. The ore is to be amalgamated in the battery and on outside plates; the tailings to be passed over Frue con-

centrators, and the sulphurets are to be worked in the company's chlorination works, which will have a capacity of three tons per day. The mill, in process of erection, is a sixty-stamp mill, with twenty-four Frue concentrators provided with water and steam power independent of each other.* The stamps will weigh eight hundred and fifty pounds each—will be given a drop of six inches ninety times per minute. The duty of each stamp will be two and one half tons in twenty-four hours. The shoes and dies will be of white iron, costing 4 cents per pound. The screens will be slot punched, and the dimensions inside the frame six inches by forty-eight inches, and will be set inclined. The size of apron will be four by seven feet, and of the sluice sixteen inches, with a length of twenty feet. The aprons and sluices will be covered with silvered plate, and will have an inclination one and one half inches to one foot. Hendy Challenge feeders, a clean-up pan, and revolving barrel will be used. The mill will save a value in the battery and outside plates, relatively in proportion as the gold is more or less coarse, other conditions being the same as at other mills on this lode.

The cost of working sulphurets is estimated to not exceed $13 per ton, whether worked by the Plattner process or by that used at the Bunker Hill, when three tons or more per day are worked.

Estimate Plattner Process.		*Estimate Bunker Hill Process.*†	
Labor	$4 00	Labor	$4 00
Wood	3 00	Wood	3 00
Peroxide manganese	65	Chloride of lime	1 20
Salt	35	Salt	15
Sulphuric acid	2 00	Sulphuric acid	1 26
Incidentals—taxes, insurance, ordinary repairs, sulphate iron, assaying material, etc	3 00	Power	39
		Incidentals, etc., same as by Plattner process	3 00
	$13 00		$13 00

The superintendence and office expense is no greater than with the general mining and milling business alone, and therefore does not enter into the cost here. It is estimated that from 90 to 95 per cent of the value of this grade of sulphurets can be saved by either process.

The number of men employed is thirty. The outside work varies, the mill being under construction. The average wages paid in the mine is $2 62; outside $2. In the mill the average will be $2 75.

Wood costs per cord $5 50, on the average, and will not be used for steam purposes, excepting in case of failure of water supply, but will only be used at the chlorination works regularly, and at the rate of about one half cord per day.

The hoisting works will require one hundred and twenty-five inches of water, with one hundred and sixty-five feet of pressure; the mill will use one hundred inches, under three hundred and ninety-one feet of head, besides the water from the hoisting works used over, with a pressure of two hundred and twenty-six feet. The cost of water is 20 cents per inch for twenty-four hours. Hoisting works cost per day for water power, $25; mill power, $20; total, $45.

*Since this was written it has been decided to use only water power at the mill.

†See Bunker Hill process described under the head of "Bunker Hill;" also "Amador Reduction Works," and "Zeile."

Developments.

Shaft No. 1	280 feet deep.
Shaft No. 2	92 feet deep.
Shaft No. 3	250 feet deep.
Tunnel	100 feet long.
North drift from Shaft No. 1	10 feet.
East crosscut from Shaft No. 1	90 feet.
South drift from Shaft No. 1	175 feet.
West crosscut from Shaft No. 1	325 feet.

Shaft No. 2 is ninety-two feet deep, and connects with the west crosscut about three hundred and seventy-three feet from Shaft No. 1. Shaft No. 3 is two hundred and fifty feet in depth, and connects with south drift two hundred feet below the surface, and at a point three hundred and sixty-nine feet south of Shaft No. 1. Nearly all these developments were made during the last year.

Proposed Improvements.

To connect Shaft No. 2 with west crosscut at a point three hundred feet below the surface, and sink to four hundred and fifty feet; to extend the east crosscut one hundred and fifty feet further to cut the east vein; to run the south drift one hundred and ninety-four feet further south. To sink shaft No. 3 one hundred feet deeper, and connect with the south drift; to erect a larger hoisting works on Shaft No. 3, capable of hoisting three hundred tons of ore daily from the six hundred-foot level; to put a large rock breaker, capable of crushing two hundred tons per day, on the south gallows frame at the shaft; to erect chlorination works, of three tons capacity, near the mill; to build a large water reservoir. The mill now being built is to be complete in every detail, and will be the largest and finest milling plant, with the exception of the Plymouth Consolidated Works, in Amador County, and perhaps in the State of California.

The plan has been changed with regard to the rock breaker. This is to be placed at the mill, and is designed to crush eight tons per hour. It is to be placed at the mill in order to render additional fall available.

Altitude (aneroid reading)	1,250 feet.
Length of ore shoot, as far as developed	600 feet.
Length of ore shaft, on incline	280 feet. 250 feet. 92 feet.
Depth of ore shaft vertically	240 feet.
Vertical depth reached in mine	240 feet.
Vertical depth of water shaft	215 feet.
Quantity of water raised in twenty-four hours	60,000 gallons.
Character of hanging-wall	Diorite (greenstone).
Character of foot-wall	Slate.
Kind of powder used	Hercules, No. 2.
Quantity of powder used per month	600 pounds.
Cost of mining	$2 per ton, estimated.
Cost of tunnel	$6 per foot.
Cost of shaft	$30 per foot.
Number of feet timbered	All.
Kind of timber	Sawed spruce 8 by 8 and 12 by 12 inches.
Cost of timber per M.	$20 50
Length of road built	2,000 feet.
Character of ore	Free milling with sulphurets.
Number of stamps	60
Weight of stamps	750 pounds.
Drop of stamps	6 inches.
Drops	90 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	No. 8 slot punched.
Water used in battery	21 inches.
Dimensions of apron	4 by 7 feet.
Width of sluice	16 inches.

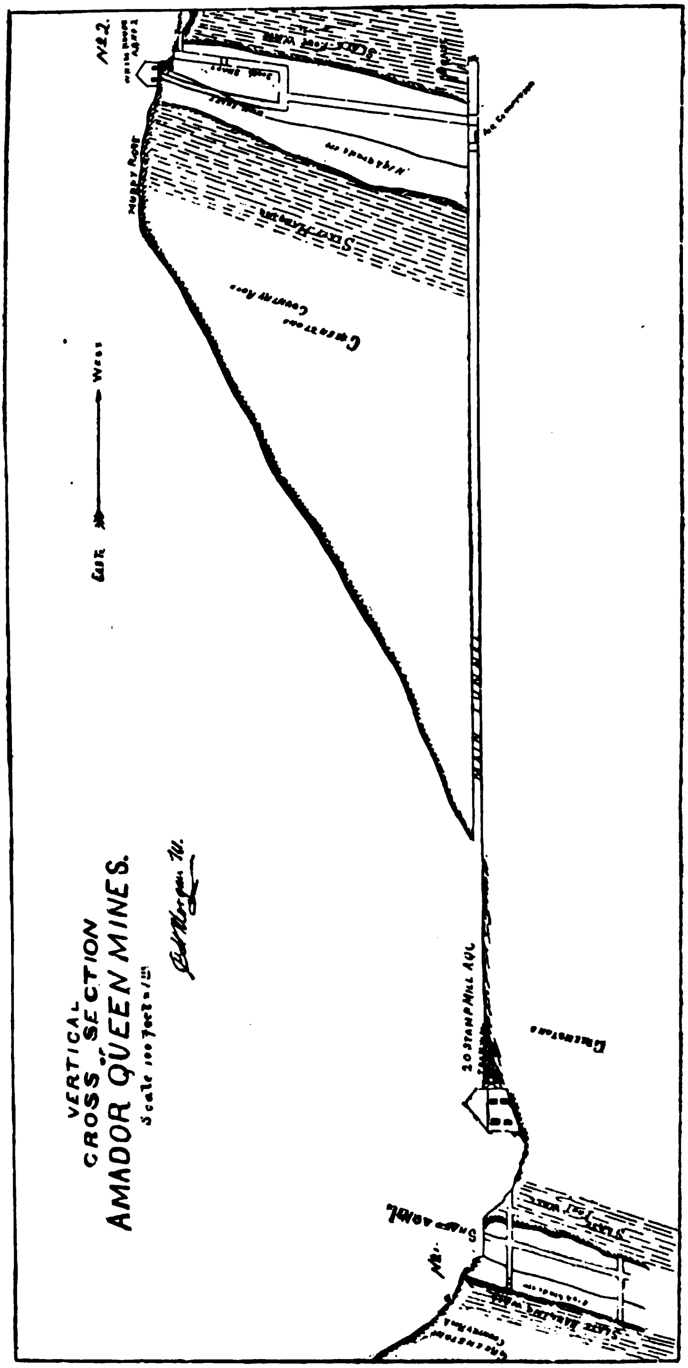
Length of sluice	20 feet.
Kind of feeder	Hendy Challenge.
Kind of concentrators	Frue's.
Percentage of sulphurets	1 to 3.
Value of sulphurets	$125 per ton.
Cost of milling, estimated	45 cents per ton.
Cost of working sulphurets, estimated	$13 per ton.
Percentage of value extracted from sulphurets	90 to 95
Number of roasting furnaces	1
Per cent of salt used in roasting, estimated	½ to 1 per cent.
Wood consumed in roasting a ton of ore, and for power	½ cord.
Number of men in mine	30
Average wages in mine	$2 62 per day.
Average wages in mill	$2 75 per day.
Average wages paid outside work	$2 per day.
Wood used per day	1⅜ cords.
Cost of wood	$5 50 per cord.
Quantity of water used in milling and for power	225 inches.
Head of water used for power	165 feet at mine; 391 feet at mill.
Quantity of water used for power	225 inches.
Cost of water for milling and for power: 100 inches at mill and 125 inches used over from hoisting works; 225 inches at 20 cents, total per day	$45

AMADOR QUEEN.

The mines of the Amador Queen Mining Company are located on the mother lode, two miles south of Jackson, and consist of a claim three thousand four hundred feet long by six hundred feet wide on the west, or foot-wall vein, and a location on the east vein, about fifteen hundred feet from the foot-wall vein, of fifteen hundred feet in length by six hundred feet in width—all covered by United States patent.

The formation is black slate west of the foot-wall vein, and the hanging-wall is diorite (greenstone). This rock continues, and forms the foot-wall and hanging-wall of east ledge. A slate casing only separates the ore from the foot-wall. The vein matter, which is quartz and slate mixed, is soft and easily crushed. The gold occurs free and in iron sulphurets, the latter assaying from $90 to $110 per ton. The west vein, which is located on a high ridge, is developed by a tunnel, run in the hanging wall a distance of one thousand and fifty feet, from the end of which an uprise was run to the surface, a distance of four hundred and ninety feet on the vein. At a point one hundred and fifty feet from the surface, drifts were extended on the vein north three hundred and fifty feet, and south two hundred and seventy-five feet, showing a width of vein matter, it is said, of eighty feet. The east vein is opened by an incline shaft, two hundred feet in depth, sunk on the foot-wall, with a crosscut running easterly to the hanging-wall. This east ledge is found to contain more sulphurets as depth is attained, with an increase of quartz in the vein matter. The course of the veins is nearly north and south.

Altitude (aneroid reading)	1,150 feet.
Length of ore shoot, not determined on surface	1,200 feet.
Length of ore shaft on incline	490 feet.
Depth of ore shaft vertically	425 feet.
Vertical depth reached in mine	425 feet.
Vertical depth of other shaft	170 feet.
Quantity of water raised in twenty-four hours	2,000 gallons.
Character of hanging-wall	West vein, diorite (greenstone), black slate; east vein, diorite.
Character of foot-wall	West vein, black slate; east vein, diorite.
Cost of mining	$1 per ton.
Cost of tunnel	$5 per foot.
Kind of timber	Round pine.
Cost of timber	Sawed, $20 per M.; round, per log, from 75 cents to $5.
Character of ore	Free milling and some sulphurets.
Number of stamps	20
Weight of stamps	950 pounds.
Drops	85 per minute.


VERTICAL CROSS SECTION of AMADOR QUEEN MINES.
East
West
No. 2.
20 STAMP MILL

Drop of stamps	7½ inches.
Duty of stamps	3 tons in twenty-four hours.
Kind of shoes and dies	Iron.
Dimensions of apron	36 by 60 inches.
Width of sluice	18 inches.
Length of sluice	16 feet.
Kind of feeder	Templeton.
Percentage of sulphurets	3
Value of sulphurets	$90 to $110 per ton.
Cost of milling	50 cents per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Head of water used for power	360 feet.
Quantity of water used for power	40 inches.
Cost of water for milling and power	20 cents per inch; $8 in twenty-four hours.

MAMMOTH OR NEVILL'S MINE.

This property is at Middle Bar, Jackson Mining District, at an altitude above sea level of one thousand five hundred feet. The company's property embraces the mining claim, with an area of two thousand two hundred and six feet in length by five hundred feet in width, and one hundred and twenty acres of timber land adjoining. The course of the vein is northwesterly and southeasterly, with an easterly dip of 75 degrees, and an average width of eight feet. The mine is worked through a tunnel, three thousand five hundred feet in length by eight feet square in the clear, which taps the vein at a depth of eight hundred feet from the surface. The hanging and foot-walls are greenstone and slate, respectively. The sulphurets, arsenical, of which there are 4 per cent, with an assay value sometimes reaching $1,500 per ton, are recovered by buddle concentration, and worked by the chlorination process at a cost of $20 per ton. The mill contains ten stamps, each stamp weighing seven hundred and fifty pounds, with a fall of eight inches, and a drop of ninety times per minute. Water is the motive power of the mill, seventy inches being used, with a pressure of seven hundred and fifty feet. The plates are fifty-two inches wide by a length of twenty-five feet for each battery. At times very rich ore occurs in the vein, especially where the matrix contains a large percentage of arsenical pyrites. This ore, so largely impregnated with native gold, is reduced in the hand mortar. The developments, besides those above mentioned, are one thousand six hundred feet of drifts, two hundred and twenty feet of uprise, and forty feet of winze.

Altitude	1,500 feet.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamps	8 inches.
Drop of stamps	90 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Size of screen	6 slot.
Water used in mill	70 miner's inches in twenty-four hours.
Pressure of water	750 feet.
Cost of mining	$2 per ton.
Cost of milling	$1 per ton.
Percentage of recovery saved in batteries	30
Percentage of recovery saved on plates	20
Percentage of sulphurets	4
Cost of working sulphurets	$20 per ton.
Length of south ore shoot	300 feet.
Length of north ore shoot	600 feet.
Length of tunnel	3,500 feet.
Number of men in mine	13
Number of men in mill	2
Average width of vein	8 feet.

This mine is not at present in operation, for reasons best known to those who have the management of the property.

THE CLEVELAND MINE.

This mine is situated about one mile north of Big Bar Bridge on the Mokelumne River. It has just been opened by tunnel and shaft. The walls are granite, and the ore fair grade. The company has completed a five-stamp water power mill, connected their ditch with the Amador Canal, and put in about three hundred feet of pipe.

RANCHERIA CREEK.

There are two or three mines being worked near this creek, east of Amador City. One is in talcose slate formation, worked by one incline shaft; the others are worked by tunnels, and are in a granite formation. In connection with these mines a ten-stamp mill, called the Talbert, has been in operation a portion of the last year. The ore extracted contained very little sulphurets, and was worked entirely by free gold process.

QUARTZ MOUNTAIN.

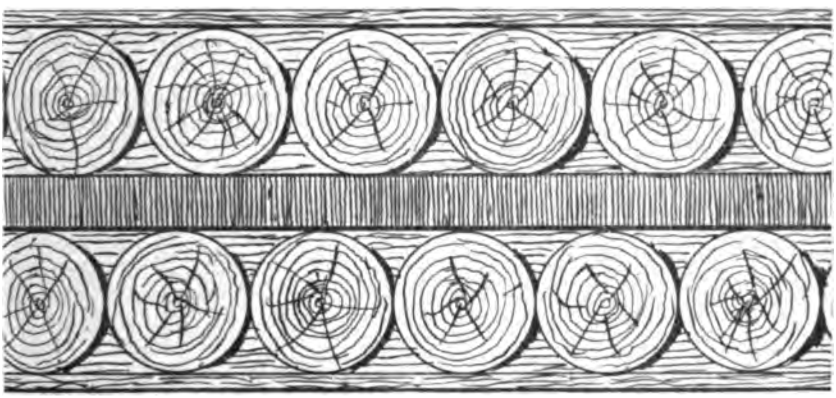
About one mile east of the mother lode proper, and two miles easterly from Drytown, there is situated a very extensive outcropping of quartz. When taking into consideration the cheapness with which this ore can be mined—quarried, more appropriately speaking—and the assay value of the ore, and facilities for working by water power, it would seem that a profitable mining industry could be established. Two companies have been operating different claims on Quartz Mountain. The Gold Mountain Company has a ten-stamp mill in connection with their mine; the other company has a Dodge crusher and Dodge pulverizer, and Frue and Golden Gate concentrators. The ore is pulverized wet in the Dodge pulverizer; amalgamated on aprons and sluices. The pulverizer reduces about twenty tons per day.

BUTTE BASIN GRAVEL MINE.

This mine consists of one hundred and sixty acres of surface ground patented. It is located two and one half miles southeast of Jackson. When worked in the early days of placer mining this ground produced a large proportion of the gold sold in Jackson, and was one of the prosperous placer sections of California, but owing to its location being in a basin surrounded on all sides by rim rocks, it could not be mined to any great depth. The principal difficulty encountered was in relieving the depression of the water which flowed from the surrounding country, there being no outlet except by flowing over the rim on the south side. Here there is a deep cañon which is sufficiently precipitous to allow of a fall of one hundred and sixty feet by running a tunnel a distance of nine hundred feet for drainage. As far as prospected and mined around the edges the rim rock is found to carry a seam from four to ten feet thick of good pay gravel. Repeated attempts have been made to reach the pay gravel by sinking shafts in the basin, but in no instance has any great depth been reached, although at least $100,000, it is said, has been expended in these endeavors, and improved pumping machinery has failed to handle the water.

CONSOLIDATED AMADOR HYDRAULIC GOLD MINING AND LAND COMPANY.

This is the only company operating in gravel at present near Volcano. The mine owned by the company is in the Volcano District, and is called the Grass Valley Mine. It consists of five hundred acres of mining ground, purchased in 1878 by the present corporation. The claim is worked for about four hundred feet in width. The deposit is worked for about twenty-two feet in depth. There is no regular channel of gravel; it is simply an alluvial deposit that has its source in the hills of the immediate vicinity. The gravel is loose, not cemented. The bedrock is a soft slate. The company, in working this mine, aim to have the water pay it about 25 cents per inch for ten hours. The gravel is washed into a flume four feet square. The water, applied above the mine, under pressure, drives the gravel into this flume, which is one and one half miles in length, filled with riffles, which are cross sections of logs placed closely together, with a six-inch thickness of scantling in the middle, shod with iron.



SECTIONS OF RIFFLE SLUICE USED.

This mine has been worked by the present company ten years. Many bowlders occur in the gravel. Ordinarily, four men are employed, but when cleaning up the sluices, which occurs yearly, fifteen to twenty men are worked for about two months. Five dams for impounding debris, the highest fifteen feet, have been made of brush and heavy timber. The water which flows through the canal to the mine is taken out of the four tributaries of the Mokelumne River—first, Panther Creek; second, Tiger Creek; third, Mill Creek; and fourth, Antelope Creek.

The canal and branches are over one hundred miles in length, and carry about one thousand miner's inches of water. A section of the canal is nine feet across the top, four and one half feet across the bottom, and three feet deep.

The company has about seven thousand feet of iron pipe, ranging from seven to twenty-two inches in diameter, through which water is being conveyed.

Altitude (aneroid reading)	1,750 feet.
Nature of pay gravel	Alluvial deposit, with bowlder wash from hills.
Nature of bedrock	Slate.
Depth of gravel, drifted	22 feet.
Best gravel, thickness	3 feet.

Length of time worked .... 10 years.
Number of men worked .... Regularly, 4 to 5; two months yearly, 15 to 20
Wages per day .... One foreman at $4, miners, $2 50

PHŒNIX REDUCTION WORKS, DRYTOWN, AND AMADOR REDUCTION WORKS, SUTTER CREEK.

These works are owned and operated by Messrs. Voorheis & Barney.

The works at Sutter Creek have been in successful operation for a period of fifteen years, and have a capacity for treating four and one half tons of sulphurets per day. The Drytown works have been in operation for twelve years, and have a capacity for treating three tons per day. The sulphurets are treated by the Plattner chlorination process. The size of the roasting furnace at Sutter Creek is fourteen by eighty feet on the outside. The works contain six large tanks, capable of leaching four and one half to six tons each per day, and six settling and six precipitating tanks, of suitable sizes.

By permission of the owners, the following figures have been taken from the books of the company, giving the actual cost of treating by chlorination, for a period of six years just past, at the Sutter Creek works, during which time $5,136\frac{860}{2000}$ tons of sulphurets were worked.

The following is a statement of the cost of labor and superintendence, and the amount and cost of materials consumed in connection with working $5,136\frac{860}{2000}$ tons of sulphurets:

Expense.	Total Amount.	Pounds Per Ton.	Cost Per Ton.
Labor and Superintendent's salary, at $200 per month	$39,339 00	....	$7 66
82 tons of peroxide of manganese, at $40 per ton	3,280 00	32	64
128 tons of salt, at $15 per ton	1,920 00	50	38
308,160 pounds of sulphuric acid, 66°, at 3½ cents per pound	10,785 60	60	2 10
2,568 cords of wood, at $6 per cord	15,408 00	½ cord	3 00
General expenses for six years, including assaying, repairing, sundry supplies, hose, tools, etc., insurance, taxes, water, new vats, interest on capital invested, repairs on furnace and buildings	19,003 20	....	3 70
Total expense	$89,735 80	....	$17 48

The assay office and laboratory, as commodious and well equipped as can be found in the State outside of San Francisco, are located at Sutter Creek, in close proximity to the works. All assays are made immediately on delivery of material, and the following percentages are paid as soon as the assay value of the material is known, and before the sulphurets have been subject to treatment:

For sulphurets assaying $50 and over per ton, 90 per cent, less $20 charges for working.
For sulphurets assaying $100 and over per ton, 92 per cent, less $20 charges for working.
For sulphurets assaying $200 and over per ton, 93 per cent, less $20 charges for working.
For sulphurets assaying $300 and over per ton, 94 per cent, less $20 charges for working.
For sulphurets assaying $400 and over per ton, 95 per cent, less $20 charges for working.
For sulphurets assaying $500 and over per ton, 96 per cent, less $20 charges for working.

If the sulphurets contain silver in appreciable quantity, payment is made for the silver, according to special agreement.

The losses are: First, mechanical loss in handling during the roasting, volatilization of chloride of gold, etc.; second, unrecovered gold in the tailings.

Method of Sampling.

The sulphurets are received at the works in sacks, usually containing the same amount. Each sack is weighed and sampled, and the sample is immediately sealed in bottles to prevent a loss of moisture, and a duplicate sent to the seller. Special arrangements are sometimes made whereby the sellers do not pay for delivery, owing to the grade and character of the sulphurets, quantity furnished, distance hauled, etc. These works, at Sutter Creek and Drytown, furnish the producers of sulphurets, in this and adjoining counties, an opportunity of realizing an immediate cash value upon their material, and as quickly as they can on gold bullion sent to the mint. The owners of the works give their personal attention to all matters in connection therewith. The works at Drytown cost $12,000, and those at Sutter Creek $15,000.

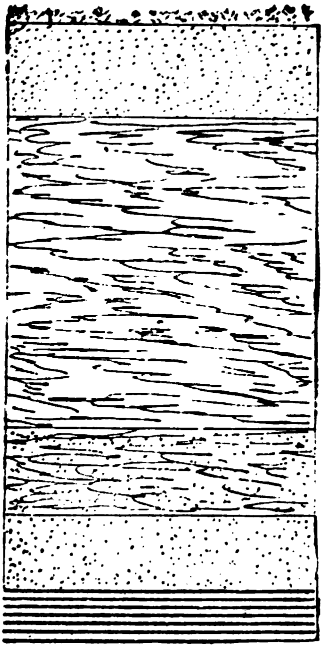
BLUE LAKES WATER COMPANY.

The Amador Canal, with its branches, follows the general line of the mother lode from Plymouth to the Mokelumne River, supplying on its way water for power to all the principal mines and mills. Even the Plymouth Consolidated, notwithstanding its immense system of canals, by reason of the extent of its mining operations, requires and uses some water from this canal. Its value to the mines of the mother lode in Amador, furnishing as it does cheap power, cannot be readily overstated. In fact, were it not for the water in this canal many of the mines now in successful operation would be closed down. The canal, about one hundred miles long, has for its sources of supply the north fork of the Mokelumne River and the Blue Lakes. Over $1,000,000 has been expended in the construction of the canal, its various branches, and reservoirs. The carrying capacity is five thousand miner's inches, but the actual delivery is between two thousand five hundred and three thousand inches. The miner's inch, as established by this company, has a pressure of four inches above the top of the slot, which is two inches high, made in a one and one half-inch plank.

The company has a telephone line connecting Sutter Creek, Jackson, Gate, Amador City, Ione, and the main distributing reservoirs along the ditch, to within eight miles of the head, four miles above West Point bridge on the Mokelumne. Also nine thousand feet of telephone line between Plymouth and the main reservoir, supplying the Pacific Mill of the Plymouth Consolidated Company. This property was formerly known as the Amador Canal and Mining Company, but disincorporated, and reincorporated March 1, 1887, under the name of the Blue Lakes Water Company. It is in contemplation to increase the capacity of the reservoirs at Blue Lakes and vicinity, and to raise the dam at lower lake six feet higher. The usual price for use of water for power is 20 cents per inch. The water itself is not sold, only its use.

ARROYO SECO GRAVEL MINE.

This mine, also known as the "Lambing," is situated in the Irish Hill District, three miles north of Ione, on what is called the "A. D. Ranch." It is worked under a lease, purchased in 1883 from the railroad company. The original term of the lease was for fifteen years, and it calls for forty-five acres, more or less. The claim is twenty-seven hundred feet long, with an average width of seven hundred feet. It follows the bed of Dry Creek in its course, and extends from hill to hill on either side. The formations passed through may be here represented:



Surface.

Five feet top gravel with no pay ground.

Sixteen feet of black loam.

Four to eight feet loam and gravel mixed.

Four feet pay gravel, average.

Bedrock; slate and diorite.

As a rule the pay gravel is not cemented, but in some places, bordering on the foot of the hills, it is slightly so. The conglomerations of gravel occasionally encountered are not very hard, and are easily broken with hammers. The bedrock is brown slate and diorite, lying in parallel bands, having a trend north northwest and south southeast, and dipping to the east 25 degrees. The average depth of the pay gravel, which is next to bedrock, is about four feet. The whole depth of overlying gravel and loam to be removed by stripping is about twenty-six feet. The pay gravel is subsequently sluiced and the bedrock swept. All of the material deposited above the pay gravel is removed mechanically, by devices which are the outgrowth of working this mine. A description of the mechanical contrivances used and the methods employed at the mine, now in successful operation, after other processes were found unremunerative, is given at some length, not so much for the purpose of representing a local mining plant, as to call attention to a novel way of handling a gravel mine, which undoubtedly is applicable to numerous other sections in this State, though ground has never been worked in this manner elsewhere. The mining operations are carried on principally in the dry season, and in the bed of a creek and on its sides, with the water of the creek turned from its course. The claim has been worked for four years. During this time the machinery here employed was invented and built, as its adaptability was ascertained. The width of the pay channel varies. It is supposed that it pays for about seven hundred feet in width. The creek has apparently changed from every point, from hill to hill, from time to time, in years gone by.

Under the present system of working no timbering is required. In the dry season the mine has to contend with about forty miner's inches of water daily. In the winter time, during floods, about five hundred and sometimes six hundred inches are encountered. In the pay gravel, in

places or "spots," a great many coarse flat rocks, water-worn, but not large round bowlders, are encountered.

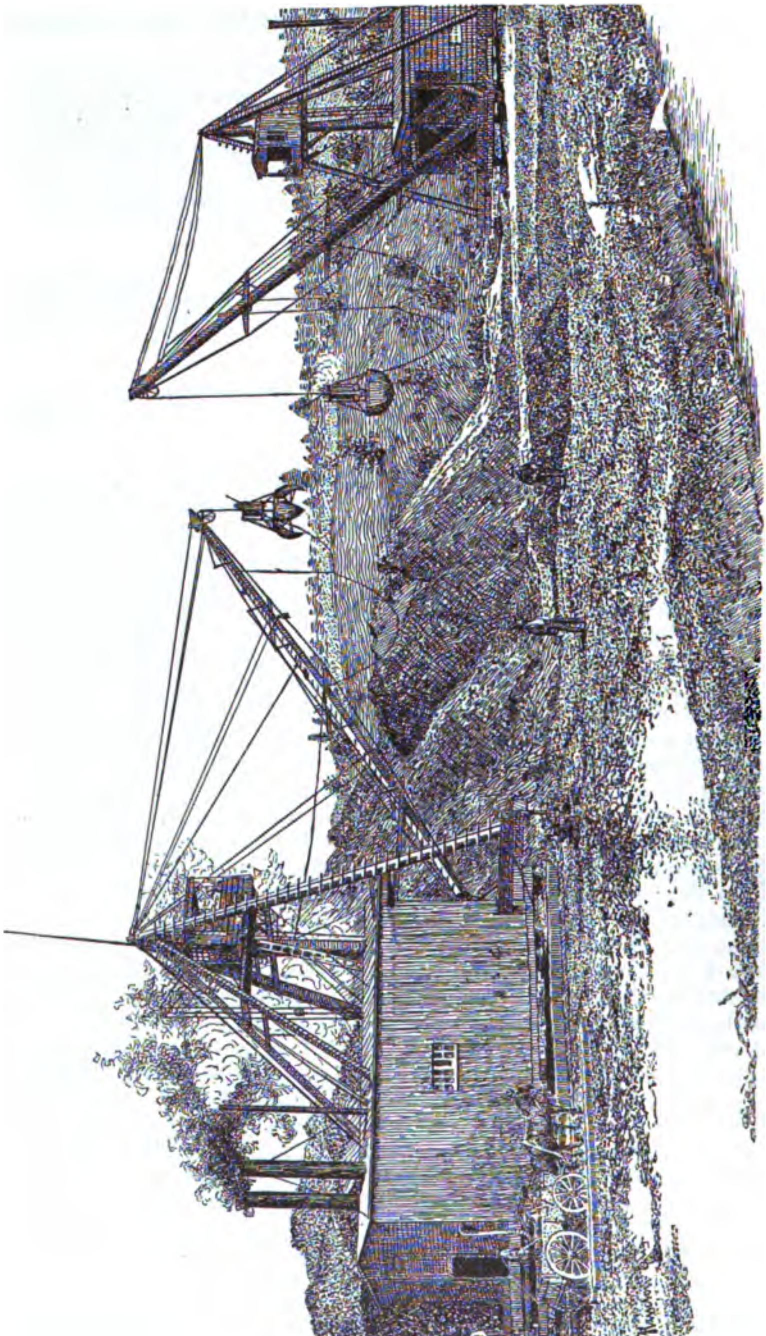
A full crew, night and day, consists of twenty-five to thirty white men, employed in running the machinery, in superintending washing pits, and watchmen for watching and bossing the Chinamen. White men receive from $1 25 to $3 per day, with board and lodging. The wages of Chinamen are $1 25 per day, without board. The machinery had never been in full operation until this summer. It is now working to entire satisfaction. The gross production is from $6,000 to $12,000 per month.

Altitude	330 feet.
Course of lead	N. N.W. and S. S.E.
Nature of pay gravel	Loose bluish wash gravel.
Nature of bedrock	Slate and diorite.
Depth of overlying gravel and loam	26 feet.
Depth of pay gravel	4 feet.
Length of time worked	4 years.
Number of men worked	25 to 30 white men; 80 Chinamen.
Gross monthly product	$6,000 to $12,000.
Gold fineness*	852 to 872.

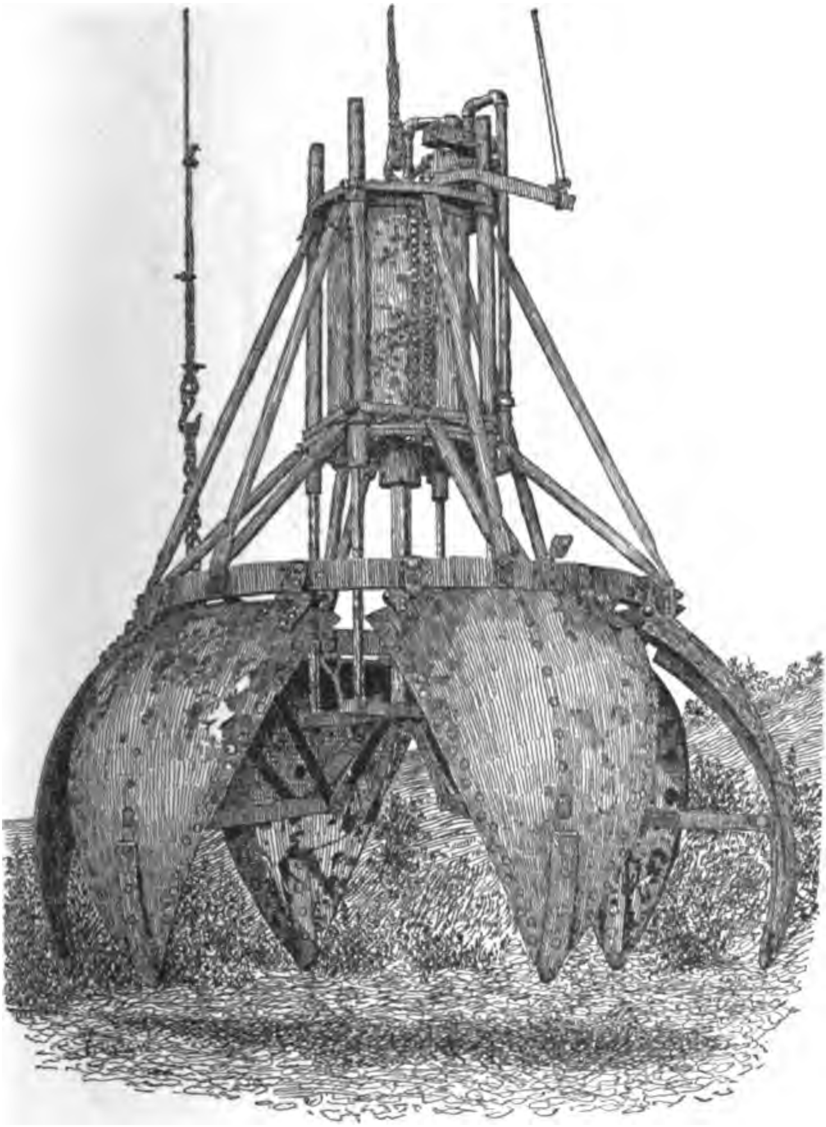
Large excavations are made by mechanical removal of the gravel. In the last two months, one excavation, having a length of eight hundred feet, and an average width of sixty, and depth of thirty, has been made. The material overlying the pay gravel is gripped by automatic grappling buckets, self-filling and self-dumping (engravings of which are shown), swung by machinery to the required distance and dumped. The usual load of the buckets is two cubic yards. One cubic yard of the gravel weighs one thousand and eighty pounds; one cubic yard of the loam and gravel weighs about seven hundred and seventy-five pounds. Commencing at the foot of the hill at any desired point, the gravel is seized and transported to any point within a radius of the capacity of the machine. The present derricks can pile it to a height of forty-five feet. The buckets are swung by a boom, which is one hundred and fourteen feet long and describes a semicircle in the air of two hundred and twenty feet. The bucket rises from the ground, the arm of the derrick swings toward the point designated, dumps its load, and returns to refill itself, and consuming from three quarters of a minute to two minutes on the trip, according to the height it is raised and the distance swung.

At one end of the claim, in the bed of the creek, is a pump pit, thirty-six feet deep, ten feet wide, and twenty-five feet long, housed, in which are two centrifugal pumps for handling the water encountered in the mine. From the bottom of this pit culverts are extended in all directions as work advances. In the fall of the year a penstock is built at the heads of the culverts, and in the spring the culverts are again extended. Several important improvements in this pumping machinery have been made by Mr. Lambing, the Superintendent, in the matter of annular casings and in rests for the vertical shaft of the pumps. A tappet, having a steel face on the underside and secured to the shaft by set screws, rests on two cast-iron pulleys, revolving on a horizontal shaft in opposite directions. In this way, the wear of the rest is reduced to a minimum. These pumps are each driven by a sixteen-inch Knight's wheel with turbine attachment,

*The gold, 872 fine, comes from the north side of the creek, showing that there are two sources of gold—one, probably, from the gold belt higher in the mountains, the other from the country on each side of the ravine. The gold is what is termed fine gold, and in character it is flattened. It is sometimes attached to small fragments of quartz, which do not seem to have come from the mother lode, along which Dry Creek runs, some seven or eight miles higher up the mountain.



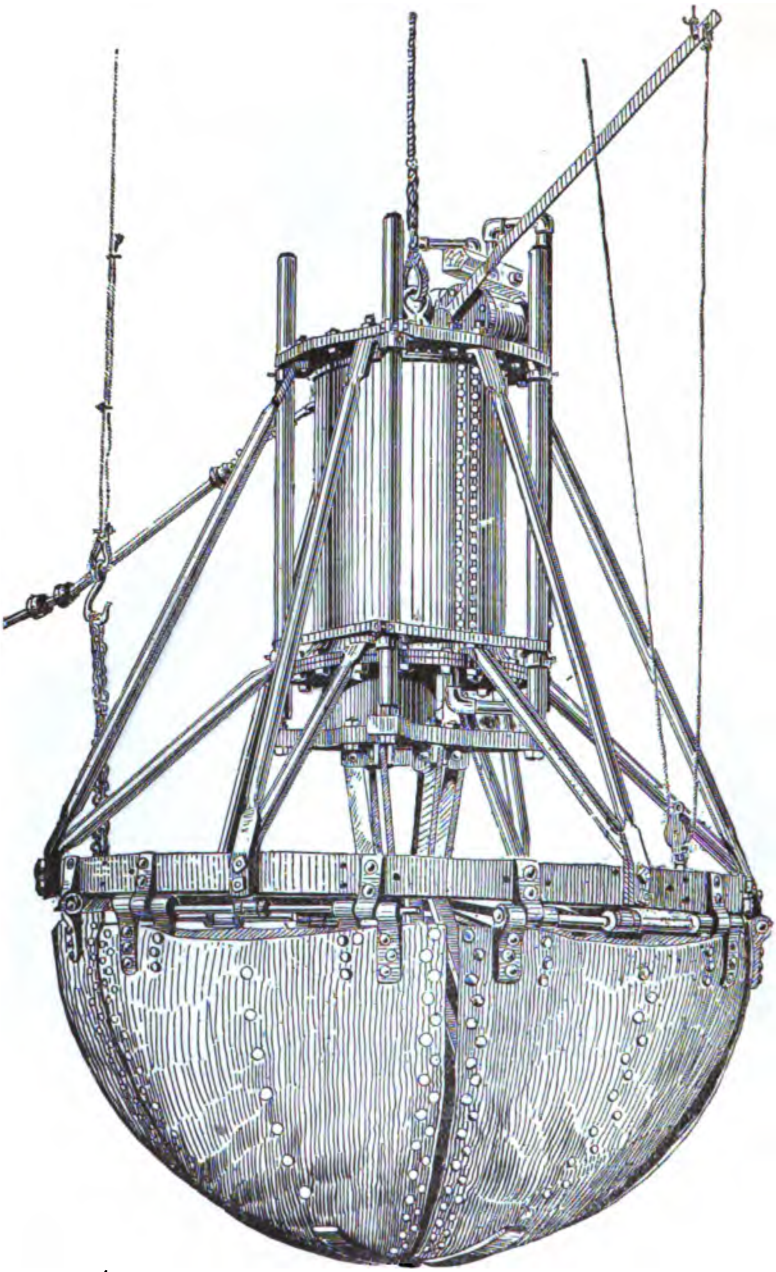
LIFT IN OPERATION.



LIFT OPEN.

having twelve nozzles with apertures two and one half by seven eighths inch. The head of water above the wheel is sixty-eight feet. A twenty-two-inch pipe conveys water for power to drive the pumps, and there is at command five hundred inches of water, with pressure of about twenty-nine pounds to the square inch. One pump is kept running at a time.

From the bottom of the pump pit, directly under the pump house, and thirty-three feet below the surface of the ground, the culvert is started in the bedrock, to get the proper grade, and is carried along as work progresses, with a grade of one fourth inch in twelve feet. The pumps are



Lift Shut.

submerged, and placed on the bedrock in the bottom of the pit. The culvert, fourteen inches by twenty, is laid as fast as work goes on, right up to the face of the excavation. By this means all water is drained from the ground being worked to the pump pit. Above this culvert another similar

one is laid, which carries the sluice water, also, to the pump pit. The bed-rock culvert is kept open, with a screen over the upper end. The water, which is pumped to the surface, is carried off by sluices. If water for sluicing becomes scarce, a portion of this water is conveyed back, in pipes, to use in sluicing. The culverts have branches at right angles, running to the face being worked, or running in all directions where work is carried on. The sluices in which the gold is saved have a grade of seven inches to twelve feet; they are of a common style, with slats three inches by two inches, laid flat through their entire length.

Quicksilver is sprinkled in the sluices according to the grade of the gravel; an ounce or two every two to four hours. The loss of quicksilver does not exceed twenty-five pounds per annum. The greatest loss is occasioned by retorting in the open air. Two derricks are employed; the weight of each, including accompanying machinery, is from seventy-five to eighty tons. The length of the boom, the outer end of which is elevated fifty-eight feet, is one hundred and fourteen feet; it is capable of carrying a load of seven tons, but usually lifts about two cubic yards of gravel. The boom is made of Oregon pine, twelve inches by eighteen inches at the foot, twelve inches by twenty-four inches in the middle, and twelve inches by twelve inches at the outer end, where a four-foot sheave is located, which carries the hoisting cable, a flexible steel wire rope, one inch in diameter.* The machine is handled by an operator, called a lever-tender, who stands about fifty feet above the foot of the mast, in a little house, near the top of the mast, where levers are attached by gas pipe to the machinery below. All is under the management of this man, who, owing to his elevated position, has full view of the surroundings and perfect control of the entire operation.

The steam cylinder is located on top of the bucket; the steam passes through inch gas pipe of various lengths, connected with globe and socket joints for flexibility.† The pipe connects the cylinder with the steam drum of the boiler of the derrick. As soon as the bucket on descending has reached the gravel, steam is turned into the cylinder by means of a five-way valve, below the piston head. This causes the piston rod to rise and draw together the clasping parts of the bucket which enfold the load; by turning the valve still further, the steam enters above the piston head, forces the rod down, and empties the bucket; turned still further the steam escapes. Each derrick has two boilers and two engines provided with link motion. Two of the engines have nine inches by twelve, and the two others eight by twelve inches cylinder and stroke respectively. In order to furnish dry steam for greater effectiveness, a large steam drum has been placed over each of the two drums on the boilers of each derrick. Each of these derricks consume about four and one half tons of Ione coal in twenty-four hours, an equivalent of about four and one half cords of pine wood.

The cost of the coal delivered at the derricks is $2 50 per ton of two thousand pounds. The derricks are easily moved forward and backward by the same engines that hoist the buckets. By throwing a clutch in gear, they become locomotives and run forward or backward at will. The machines rest on a solid railroad track, with sixteen-foot gauge, and the heaviest rails are employed. The track is laid on heavy Oregon pine timbers twelve by sixteen inches in size. Twice as much track is laid as the derrick covers. As the derrick advances the length of timber behind is

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*Before using tar two ropes per annum were required. After using tar occasionally, one rope only was needed yearly. By tarring every three or four days, the rope has kept in good condition for the last two years.

†Carbolized steam hose, which was at first used, was found to be insufficiently durable to be effective.

removed to the front. If the movement is backward, the track in front is removed and laid in the rear. The cost of a single derrick has been about $10,000, but it can now be duplicated for a much less sum. The company is provided with first class boarding and lodging houses, to accommodate one hundred and fifty men, blacksmith shop, company's office, and Superintendent's residence.

BUILDING AND USEFUL STONE.

An excellent sandstone for building purposes occurs over the clay, just above the coal of the Lancha Plana beds. On the south side of the hill, where found, it is pinkish or red in color; on the north side white. The red sandstone can be readily split into slabs of any desired thickness. It can be sawed when first quarried, but subsequently, on exposure to the air, becomes quite hard. A sample may be seen in the rails at the Court House entrance at Jackson, which have remained in place for over twenty-five years. This red sandstone resists the action of fire without cracking, and is often used satisfactorily for backs in stoves, and has been used at Campo Seco for lining roasting furnaces. It has the advantages of being very durable, weathering but little, splitting most readily, and being easily dressed, and withstanding fire. Of the white variety, which is less readily split, but otherwise easily worked, and very fine grained, there is an immense supply.

A body of serpentine, varying in color from dark green to dark mahogany, is situated six or seven miles northeast of Ione, near Dry Creek, on the road between Ione and Plymouth, near the ranch of Messrs. Voorheis and Barney. It is said to be nearly one hundred feet wide in its greatest width, and below the surface solid in places.

A quarry of marble is situated on the Latrobe road, about four miles west of Plymouth, and it yields both white and variegated varieties of rock of good character for building purposes, but too coarse grained for fine work.

Another quarry, northeast of Plymouth on the Oleta road, furnishes considerable material.

Six or seven miles northeast of Ione there is a quarry of red marble, showing extensive cropping. The rock is very hard and difficult to work, but is susceptible of a high polish.

DIAMONDS.

About fifteen years ago, one Chris. Wisner found some twenty diamonds about one mile north of the town of Volcano. Most of them were clear, but some were off color. They came from a tunnel he was running in gravel, covered with about forty feet of lava. These diamonds were all found during the short period the tunnel was being worked, which was about three months. The diamonds were discovered in testing the gravel for gold, from time to time, in a miner's pan. One diamond from this tunnel was recently sold for $33. The tunnel has been abandoned for about fifteen years. There is little doubt, had the true value of the stones been known at the time the tunnel was worked, more careful search and washing of all of the gravel would have revealed very many more. The ground has been examined by experts who have had experience in washing for diamonds in Africa, and the conclusion to which they arrived was, from trustworthy history of the mine, that diamonds here are sufficiently plentiful, and in size and quality of a standard to justify systematic search for them, were the gravel less cemented. It is quite within the range of possibility,

if not probability, that this difficulty of handling cemented gravel, by mechanical contrivance could be overcome sufficiently to make diamond mining remunerative in Amador County. The alluvial deposits, in which diamonds are found in India and Brazil, are said to be conglomerates more or less tenacious, and the diamonds are said to follow the law of the gold with which they are associated, that is, of most plentiful occurrence, and in largest individual size, nearest the bedrock. It may be that mining for gold and diamonds could be profitably combined in this district. This territory does not seem to have been sufficiently prospected for precious stones, for any one to pass a decided opinion.

At a meeting of the San Francisco Microscopical Society held about year ago, Henry G. Hanks read an interesting paper on diamonds, and exhibited specimens. The paper, being of general interest in this connection, is here reproduced:

"Diamonds were discovered in California as early as 1850. In that year Rev. Mr. Lyman, of New England, saw a crystal in the new gold mines about the size of a small pea. It was slightly straw-colored and had convex faces. From that time to the present, these gems have been occasionally found in our State, but never in large quantities, or of unusual size. It has long been my opinion that if hydraulic mining had been allowed to continue, a system of concentration would have been adopted, resulting in a greater production of gold and platinum, and in the finding of more diamonds. At the present time we know of the existence of diamonds in five counties in the State, as follows: Amador, Butte, El Dorado, Nevada, and Trinity.

"It is not yet unlikely that they may be found in California more plentifully than before.

"A very beautiful, and, I think, remarkable diamond has lately come into the possession of Mr. J. Z. Davis, a member of this society, and it is here this evening for your inspection. It was found in 1882 at Volcano, in Amador County, by Mr. A. Schmitz.

"It weighs 0.361 grams or 5.570 grains, equal to 1.571 carats. It is a modified octahedron, about three tenths of an inch in diameter, very nearly, if not quite, colorless, perfectly transparent, but not without some trifling inclusions and faults. The form of the crystal is unusual. I have not found such a one described or figured in books. You will notice that the general form is that of a regular octahedron, but that the faces seem convex, the whole crystal assumes a somewhat spherical form, and the edges of the pyramids are channels instead of planes; but on closer examination it will be seen that the channeled edges, the convex faces, and the solid angles are caused by an apparently secondary building up of the faces of a perfect octahedron, and for the same reason the girdle is not a perfect square, but has a somewhat circular form.

"The faces seem to be composed of thin plates, overlying each other, and each slightly smaller than the last. These plates are triangular, but the lines forming the triangles are curved, and the edges of the plates themselves are beveled. It will be seen by the enlarged crystal viewed under the microscope, that each triangular plate is formed of four smaller triangles, and that all the lines are slightly curved. The building up of plate upon plate causes the channeled edges and the somewhat globular form of this exquisite crystal.

"A close examination of the crystal will reveal tetrahedral impressions, as if the corners of minute cubes had been imprinted on the surface of the crystal while in a plastic state. These are the result of the laws of crystal-

lography, as may be seen by the faint lines forming a lacework of tiny triangles on the faces, when the stone is placed in the proper light."

THE NEWTON COPPER MINE.

This mine is situated by the side of the road from Ione to Jackson, four miles from the former and eight miles from the latter place. It was located very many years ago; was once worked vigorously and successfully, but had been closed down for six or seven years, save some little leaching of old piles, from time to time. During the past year operations have been resumed. The hoisting works have been repaired; the water has been removed from the mine; the shaft and old levels have been reopened; ore is again being extracted; tracks and trestle being constructed, and active preparations are made for roasting ore and making cement copper on an extensive scale.

The course of the vein is a trifle east of north and west of south, dipping about 62 degrees easterly, and the average width is considered about seven or eight feet. The dimensions of the claim are one thousand five hundred by six hundred feet. The ore shoot has been explored for about four hundred feet, yet the northern end of the shoot has not been reached. There are two shafts on the property. No. 1 is four hundred and thirty feet deep on the incline, or about three hundred and seventy feet perpendicular. Shaft No. 2 is about one hundred and fifty feet in vertical depth. The formation of the country rock is slate, both on the hanging and foot-wall side.

In the summer time the mine yields about twelve thousand five hundred gallons of water daily. In winter about double that quantity. The water is removed with buckets.

Drilling is done by hand. About one hundred pounds of Safety Nitro powder, No. 2, are consumed monthly. One dollar and seventy-five cents per ton is the amount given, as a close estimate, of extraction and delivery of ore upon the heaps, for roasting.

As the shafts were sunk and levels run on the mine many years ago, no record of cost per foot, number of feet sunk per day, or other historical data could be readily obtained. The shafts were sunk through vein matter, and were timbered with round timbers, as were also the levels throughout the mine.

The present cost of timber at the mine is from $2 50 to $5 per log sixteen feet long, with diameter at the smaller end from twelve to twenty inches. This price rules in consequence of distance of mine from timber, which is about thirty miles away. Sawed lumber is, however, obtainable at present for $20 per thousand feet. Transportation from shaft to place for roasting is embodied in stated cost for mining. The ore is a mechanical mixture of iron and copper pyrites, sometimes slightly oxidized, and in general said to be unusually easy of oxidation on exposure. The ore is roasted in heaps for about six months, about two thousand tons being placed in each pile.

The base of one of the roasting heaps, now being formed, is twenty-four feet wide, and two hundred and eighty feet long. Every sixteen feet on each side is a flue for draught, sixteen inches high and eighteen inches wide, and a similar one at the center of each end of the heap. These flues are built of brick, loosely piled outside of the base of the heap, and terminate exteriorly, the main flues through the pile—made by the arrangement of the wood employed as fuel. A chimney six by six inches in the clear is placed vertically in the center of a longitudinal flue, or at con-

venient intervals, for promoting draught. A wooden trestle, sustaining the car track at desired height, is placed over the whole length of the heap for assisting in distribution of the ore in arranging the pile. This is burned in roasting the heap and is replaced by another, when a second heap occupies the place of the first one. After the ore has been sufficiently roasted, the surface of the pile is subjected to spraying with water in various parts, so long as any copper solution is formed. The solution then passes through sluices two feet wide and one foot deep, containing scrap iron, and sufficient length of sluices are provided to allow precipitation of all the copper, and to prevent the solution, after passing the last sluice, from giving a reaction for copper by ammonia test. The resulting impure precipitate, termed cement copper, is dried over a furnace and shipped in sacks to the East by way of San Francisco.

The hoisting works are operated by steam. The boiler is tubular, fifty-four inches in diameter, and fourteen feet long. The engine is a fourteen-inch cylinder, with stroke of thirty inches. Double reels are used, five feet in diameter. The gear is pinion and spur. At present twelve men are employed in the mine, and eight on the outside work, or a total of twenty. The average wages per day in the mine are $2 50, and for outside work, $2. Ione coal is used for steam purposes, and about one and one half tons are consumed daily. The coal costs, delivered at the Newton Mine, about $5 per ton.

The developments on the mine consist of one incline shaft, four hundred and thirty feet deep; one incline shaft, one hundred and fifty feet deep. The size of each shaft, in clear of all timbers, is four and one half by eight feet. Level No. 1 is two hundred feet long; No. 2, three hundred and eighty feet; No. 3, one hundred and fifty feet; No. 4, fifty feet. It is generally believed that there is an abundance of good ore in the mine and in the bottom, and it is stated that there have never been crosscuts made.

Altitude (aneroid reading)	650 feet.
Length of ore shoot	400 feet.
Depth of Incline No. 1	430 feet.
Vertical depth reached from surface by No. 1	370 feet.
Vertical depth reached from surface by No. 2	150 feet.
Quantity of water raised daily	12,500 to 25,000 gallons, according to season of year; most in winter months.
Walls of the mine	Slate.
Powder used	Safety Nitro, No. 2.
Quantity consumed monthly	100 pounds.
Cost of mining	$1 75 per ton.
Timber used	Round pine.
Cost of timber	$2 50 to $5 per log.
Cost of sawed lumber	$20 per thousand feet.
Cost of transportation of ore	No separate account kept.
Character of ore	Mechanical mixture of iron pyrites and copper pyrites.
Treatment of ore	Roasted in heaps.
Number of men employed in mine	12
Total number of men employed	20
Average wages paid in mine	$2 50
Average wages paid on outside work	$2
Kind of fuel consumed	Ione coal and wood.
Amount of fuel consumed daily—coal	1½ tons.
Amount of fuel consumed for two thousand tons of ore—wood	20 cords.
Cost of coal, delivered	$5 per ton.
Cost of wood, delivered	$5 per cord.

In these large roasting heaps, the dimensions of which have been already given, great care is taken to make the draught, when the heaps are burning, most effective and under best control. For this purpose, in constructing the pile, the cordwood, which is placed on the bottom every sixteen feet, is laid crosswise of the pile in sufficient quantity to form a

horizontal flue from side to side, connecting with a longitudinal horizontal flue of wood running from one end of the pile to the other. All of the flues terminate with horizontal brick flues on the outside. The spaces between the flues of wood are filled brush, about one foot in depth. A center vertical flue, constructed of boards, connects with the main central flue and assists in carrying off sulphurous acid and in promoting draught.

About six inches or one foot of wood and brush, traversed with horizontal flues, as represented, constitutes the first layer, over which is piled about one and one half feet of coarse ore. Then a second layer of wood and brush, two or three inches thick, is arranged, over which is placed a couple of feet of ore. Then another layer of fuel, principally brush, is placed over this; then about two and one half feet of ore; then about two feet of fine ore for covering. Thus there are three different layers of wood and brush, conveniently arranged for securing draught or keeping it under control. All of the ore as it comes from the mine is dumped from cars, which run over a trestle that stands over the pile, on top of the first or bottom layer of wood and ore. A similar arrangement of brush and wood is made, connecting with the outside of the pile, as before. The precipitating sluices are three in number, about two hundred feet in length, with partitions every sixteen feet, reaching nearly to the top of the sluice, and the solution is constantly passing over them. The cement copper is run into a vat and washed before drying.

It is not possible to closely calculate the output of copper. It is intended to keep four piles of two thousand tons of ore each roasting at the same time. Fresh iron is put into the sluices every twenty-four hours and mixed with the old supply, the heaviest iron being placed at the upper end. The sluices are cleaned up when full of cement copper, perhaps once each month.

CLAY.

Clay is mined in and near Carbondale Station, six miles from Ione, on the branch railroad to Galt. Mining clay banks in this neighborhood has become an industry worthy of note. Various banks or beds are opened, yielding different kinds of argillaceous material, in a belt running a little west of north. From this clay is manufactured, on this coast, sewer pipe, terra cotta, stoneware and fire-brick of first quality.

Four companies are operating in this locality. N. Clark & Sons derive a portion of their supply of clay from off the Arroyo Seco Ranch, through which the railroad runs, and a portion from their own land, four and one half and five miles northwest of Carbondale. They mine through the entire year, having erected sheds near the railroad for storing, under cover, all surplus over shipment. The other parties engaged in this business obtain their product during the dry or favorable season. Parker & Jobson are mining this material two and one half miles north of Carbondale. Bradley & Co. are working clay beds one mile west of the station. Mr. Madox is also mining clay in this vicinity. An average monthly output, in tons of two thousand pounds, is stated as follows: N. Clark & Sons, 675 tons; Parker & Jobson, 225 tons; Bradley & Co., 60 tons; Madox, 15 tons; total, 975 tons.

Clay is delivered on board the cars at a cost of from $1 to $2 per ton. In carload lots freight charges are $2 per ton to Oakland, San Francisco, or Sacramento; hence, the entire cost of the product delivered in these cities is from $3 to $4 per ton of two thousand pounds.

An analysis of a sample of clay, made by John Eitel, Sacramento, is as follows:

Silica	61.300
Alumina	26.975
Oxide of iron	0.945
Lime	2.600
Magnesia	0.600
Soda	2.753
Potassa	0.937
Water	3.300
Total	99.410

Five different grades or varieties of clay are recognized in this district, and kept as nearly separated as reasonable care will permit. All are nearly white in color, and are best in quality near the surface of the ground. Some stripping is necessary. From two to four feet in thickness of surface soil or gravel is removed, and the underlying clay beds are from four to twenty feet deep, resting on quicksand.

From five different clay banks as many varieties of clay are obtained: First grade—White porcelain clay capable of producing first class chinaware. Second grade—Stoneware clay. Third grade—Pipe clay for sewer pipe, of poorer quality than grade second. Fourth grade—Fire clay carrying a large percentage of sand. Fifth grade—Fire sand associated with just enough clay to cohere. The supply is sufficient for hundreds of years at present rate of shipment.

Under the quicksand lie other beds of clay, but that near the surface is much purer in character, and hence much more desirable, even were the cost of extracting the material from the lower beds the same. These clay beds have a general course with, and invariably overlie, a great coal channel, if it may so be called, which runs through the county near the meridian, having a general strike a little west of north and south of east, magnetic. The outcropping clay is considered best. Wherever, on this belt, the clay is found, the coal occurs from forty to eighty feet below it, as a general rule, to which, as yet, no exceptions have been found. The "coal" is a brown lignite, more or less poor, but in certain localities profitable to extract, and serves as a cheap and desirable fuel in the immediate neighborhood.

BROWN LIGNITE—LANCHA PLANA.

There are other coal fields in Amador County, differing widely in overlying strata from the coal beds found in the Ione and Buckeye Valleys, which continue beyond the Mokelumne River into Calaveras County, but thus far have not been found extensive in the latter county. A distance of ten miles southeast from Ione, and one and one half miles northerly from Lancha Plana, more definitely locates the situation.

Wallace Station, on the narrow gauge road to Valley Springs, is the nearest point for shipment, though crossing the Mokelumne River is likely to be a serious inconvenience in freighting at all seasons. Two companies have done something in the way of development work, which will be spoken of more in detail; but the expense of transportation, and insufficient demand, combined, have prevented extensive operation. M. Murray and others hold a United States coal patent on one hundred and sixty acres.

The Stockton Paper Mills Company owns eighty acres of coal land in this vicinity.

LANCHA PLANA COAL MINE.

In the locality of Lancha Plana, as is the case near Ione, the existence of three coal seams has been ascertained. No. 1, or the upper vein, has

been followed by a tunnel one hundred feet, showing an average thickness of twelve to eighteen inches. The thickness increases as distance is gained in the hill. No. 2, or the middle vein, has been followed by a tunnel for four hundred feet. It commences at the surface with a thickness of about two feet, and at four hundred feet from the mouth of the tunnel it increases to over five feet. The lower vein, or No. 3, is said to show a thickness at the surface of about two feet, but no work has been done on it. The dip of the Lancha Plana coal veins is slight and to the north and west. A stratum of bluish clay lies under each of these veins of coal, and about twenty-five feet of clay lies over them.

The surface of the hill, in which occurs the coal, is covered with large loose wash bowlders. Underlying a light surface soil is sandstone about one hundred and seventy-five feet thick; below the sandstone is bluish clay about twenty-five feet thick; below the bluish clay is the first stratum of coal about one to two feet thick; below first coal stratum is bluish clay about twenty-five feet thick; below the second clay bed is a second stratum of coal about two to five feet thick; below the second coal stratum is bluish clay twenty-five feet thick; below the third clay bed is third stratum of coal two feet thick; below the third stratum of coal is bluish clay.

The four-hundred foot tunnel, excavated on the Murray ground, is about one hundred and fifty feet higher than the surface of the Stockton Company's ground. The latter company has a shaft about one hundred feet deep on a coal vein which is said to be about seven feet thick when worked. Neither company, near Lancha Plana, has water to contend with.

STOCKTON PAPER MILLS COMPANY.

This company is said to have extracted about seventy-five tons of coal, which was taken to Stockton for trial. It, however, cost the company so much to ship to market that work was discontinued. This coal is said to be harder than the Ione coal, and more lustrous, and is conceded to be better in quality. Like the coal nearer Ione, it carries a large percentage of volatile matter.

IONE COAL AND IRON COMPANY.

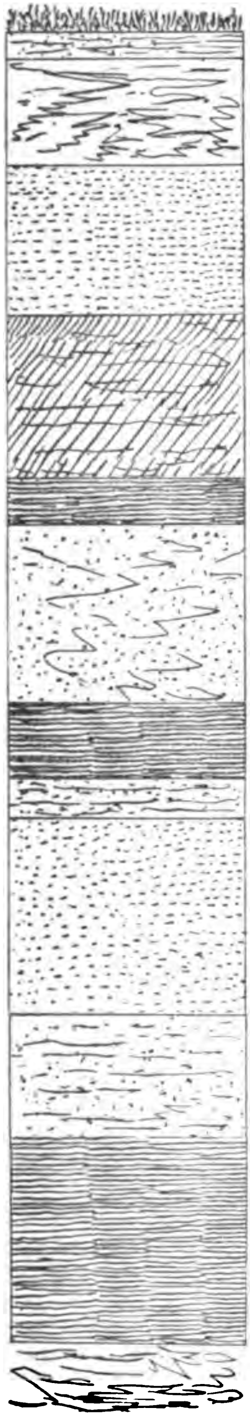
Coal occurs in the Ione and Buckeye Valleys, and also one and one half miles north of Lancha Plana. The last named locality is not at present in production, owing to distance from rail.

Ione and Buckeye Valleys are represented in coal mining by two companies, each producing from seventy to one hundred tons per day, according to the demands of the market.

Ione, the terminus of the branch railroad from Galt, on the main line from Oakland to Sacramento, via Livermore, is situated within five miles of the western boundary of Amador County, in a direct line, and nearly midway, between the Cosumnes and the Mokelumne Rivers, at their extreme divergence.

In Buckeye Valley, three and one half miles northwesterly from Ione, are situated the coal fields belonging to the Ione Coal and Iron Company, consisting of thirty-four thousand four hundred acres of land.

The shaft now operated—No. 3—is an incline, one hundred and sixty feet deep on the slope, reaching a perpendicular depth of eighty feet. The coal is hoisted in cars, holding one thousand pounds each. A twelve by twenty-four engine, connected with tubular boiler, drives the hoisting machinery Three and one half-foot double reels are used, with pinion and spur gear



Surface soil	1 ft. 6 in.
Surface clay	5 ft. 6 in.
Compact white sand	10 ft. 0 in.
Bluish clay	10 ft. 0 in.
Brown lignite	2 ft. 6 in.
White clay, slightly sandy	11 ft 6 in.
Brown lignite	4 ft. 0 in.
Sandy clay	2 ft. 0 in.
Very fine white sand	12 ft. 0 in.
White clay with a little sand	8 ft. 0 in.
Brown lignite	13 ft. 0 in.
	80 ft. 8 in.

Forty-seven feet below surface—water.

Blue clay under third stratum.

About one ton of fuel is consumed in twelve hours, in hoisting a daily average of one hundred tons of coal.

There is connected with the main gangway a pump shaft eighty feet deep. The water is extracted by a No. 5 Knowles pump, which is kept running, by means of a steam boiler, ten hours in twenty-four, summer and winter alike. There is no sensible difference in the flow of water in the mine at any season. Forty thousand gallons per day are yielded.

The incline is situated near the railroad, and a carman dumps the ore into different bunkers; some of them holding coal for house consumption, and some for steam purposes. Bunkers are provided for local or railroad demand. The present shaft, or No. 3, has been in operation about three years. When the coal has to be transported too far underground, the hoisting works are moved to a more convenient locality, and a new shaft sunk.

The present bed of coal has been penetrated, by underground workings, about one half mile in length. The further into the valley the coal is explored, the softer and more friable it becomes, until it is not profitable to extract it. The coal is of better quality toward the mountain, poorer in direction of the center of the valley.

In the main incline Oregon pine timber is used, which costs about $28 per thousand; lagging costs 8½ cents each, and sawed mountain pine $22 per thousand. The incline shaft is a double compartment; its dimensions are ten feet by four feet six inches in the clear. The timbers are ten inches square. In sinking the perpendicular shaft connecting with No. 3, an excellent opportunity was afforded of noting the successive formations overlying the coal, and the thickness of each.

A statement is here given of the different strata encountered. A section on page 111 represents eighty feet in depth. Underneath the lower stratum of coal lies a dark bluish sandy clay. This stratum has been penetrated in two places, by boring, to a depth of six hundred feet—one in Buckeye Valley, and one in Ione Valley. This formation was not passed entirely through, notwithstanding so great a depth was attained. No water was encountered in either exploration. Specks of coal were found, here and there, scattered through the clay for twenty feet below the lower stratum of coal, then these indications of the proximity of coal beds ceased altogether, and the material passed through to deepest depths attained was a mixture of dry clay and sand; but bedrock proper was not reached below the third stratum of coal, in either Ione or Buckeye Valleys. In regard to the coal of Amador County, it may be said that it belongs to the later pliocene, the same age as the lignite occasionally found in seams of the auriferous gravel underlying basaltic lava in several counties.

Mode of Occurrence.

The best stratum of coal is invariably the lowest of the three parallel strata, and is usually from nine to twelve feet thick, overlaid with a few feet of white clay. It lies nearly horizontally, but conforms quite closely to the surface of the ground. The coal appears to have filled extensive potholes, following the general course of a channel or belt a little west of north. Previous to working Shaft No. 3, this company worked a bed vein in Ione Valley, about one and a half to two miles from Ione. Its superficial area was about twenty-three acres. It was shaped like a basin, or at least the better coal was found to assume such a shape, while coal too soft to be profitably extracted occupied the basin's rim, defining it; the thickness also becoming less. For this reason, as well, it was unprofitable to longer con-

tinue extracting in this immediate vicinity. This body of coal varied from twenty-five to fifty feet in depth from the surface.

Cost of Extraction.

The coal is dumped and shoveled into dump cars at a contract price of 40 cents per ton of two thousand pounds, and then hauled by mules to the foot of the incline, and by steam power it is raised to the surface. The entire cost, as stated by the Superintendent, amounts to 78 cents per ton, delivered on board the cars. Thirty-two men find employment in and about the mine—twenty-eight under ground, and four above. Those not under contract receive the following wages: Timbermen, $3 per day; blacksmith and engineer, $3 per day; miners, $2 50 per day; mule drivers, $2 25 per day. The present rate at the mine is $2 per ton for lump coal, and $1 50 for that used for steam purposes.

In "Coal Mine No. 3," the "rim of the basin" has not been touched at any point, and the extent of the bed is consequently undetermined. This vein has been explored, by underground galleries, for one half mile. Borings have been made in various places for three miles from the present shaft, in a northerly direction; for three quarters of a mile in a southerly, one half mile in an easterly, and thirteen hundred feet in a westerly direction. Each penetration revealed full thickness of coal, and no "rim," so called, of the basin has so far been discovered.

Powder is not used in the mine, and all work is carried on in the daytime. The present shaft has been in operation about three years, though coal has been mined in the valley from a very early date. The coal is used extensively as fuel by those living in proximity, some mining companies near by, and by the railroad company on the branch railroad from Galt, and by the gas works of several towns of the State. It contains an abundance of gas, which requires purification, but is profitable to use in gas manufacture, owing to its comparative cheapness.

The coal also carries a large percentage of water, and when first extracted burns sluggishly, like green wood; when dry, however, in spite of some slacking, it makes a good coal for house purposes, and yields no clinker. The impurities are principally clay and iron pyrites.

It is in contemplation to move the hoisting works and coal bunkers one and one half miles nearer Ione, some time during next year.

THE SACRAMENTO IONE COAL COMPANY.

The property of this company is situated in Ione Valley, about one mile west of Ione. It consists of one hundred and thirty-two acres of coal land with mining equipments. The title is derived from Mexican grant. This land was segregated at an early day from the main Pio Pico grant of the Arroyo Seco Rancho, consisting of many thousand acres.

The coal bunkers are connected by sidetrack with the Ione branch railroad. This mine has been in operation for over twelve years. The developments consist of a main incline, having a southerly slope of one half inch in one foot for five hundred feet; a main drift through the coal eight hundred feet, and exploration on the east side for one thousand feet, one a shaft seventy-five feet deep, the second air shaft fifty-four feet deep, connecting with the main drift one thousand feet southeasterly from the mouth of the incline. In this mine two coal strata occur. The upper one, three feet above the lower one, has an average thickness of eight inches. The lower one, varying in thickness from six feet to twenty-four feet, is separated from

the upper and smaller stratum by about three feet of brownish-white clay. Below the lower stratum of coal there is always found white clay.

From six to twelve feet of thickness of coal, which is the better portion, is extracted. As in the other coal mine near Ione, no powder is employed. No hoisting works are needed, but mules are employed to bring the coal up this slight incline (which may be considered more of a tunnel than an inclined shaft), in cars holding an average weight of sixteen hundred pounds. One side of the mine is worked at a time. The other side is simply blocked out and left standing, that the coal, when removed, may contain less water.

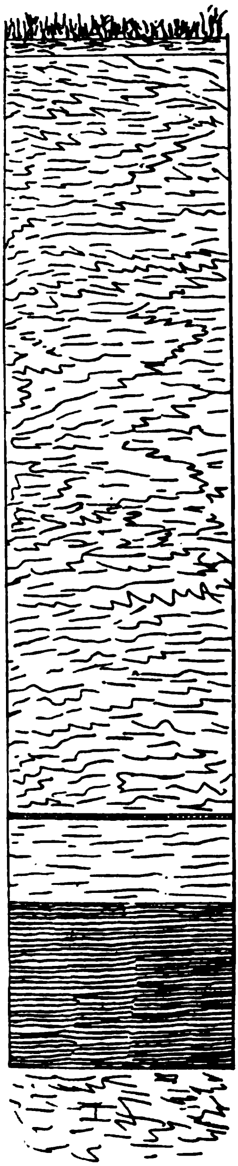
The same prices obtain for this coal as for that of the other producing mine: $1 50 per ton for that which is more finely broken and $2 for "lump," or house coal. The usual yield of this mine is seventy tons per day, and the coal is sold as fast as extracted.

There is very little water in this mine, even during the rainy season. A boiler on the surface supplies steam for operating a No. 3 Knowles pump, placed at the bottom of the mine. In summer season six hours' pumping per day is required; in winter ten, with an average speed of sixty strokes per minute. No lagging is used in the mine, and no other timber is required than posts and single caps. These caps are usually four by six inches and eighteen inches long. The timber for posts is of all kinds, and anything is taken that may be conveniently found on the ranch. So posts may be seen four inches or twelve inches in diameter, holding up ground of the same weight.

The contractor mines and delivers the coal into bunkers near the railroad switch, for 75 cents per ton, and furnishes labor, tools, oil, and mules. He employs about twenty men and boys, at rates from $2 50 to $1 50 per per day. One man is employed on the day shift at $3 50 and one at night for $3. For miner's lamps whale oil is used; of this there is consumed monthly, for lights in the mine and lubricant for car axles and pump, about forty-five gallons.

The coal is mined in blocks fifteen feet square and six to twelve feet thick. After blocking out into squares, each alternate square is taken, commencing at the soft coal on the outer rim of the basin; then the alternate pillars which were left are removed, and in their stead are placed posts and single caps, about four feet apart. The ground is then allowed to cave. In this way all the coal of suitable grade is removed. The altitude of the mine is about two hundred and seventy feet. The reserves in this body, now being worked, are estimated to be between thirty and thirty-five thousand tons.

The seventy-five-foot shaft passes through two feet four inches of surface soil and gravel; forty-four feet of white clay; eight inches of the first stratum of coal; four feet of brownish clay with no grit, and twenty-four feet of the second stratum of coal. The white, sandy clay below the coal was penetrated ten feet. The fifty-four-foot shaft, connecting with the main drift, passed through—



Surface soil	1 ft. 0 in.
Whitish clay	41 ft. 0 in.
First seam of coal	0 ft. 3 in.
White clay	4 ft. 0 in.
Second seam of coal	9 ft. 0 in.
Shaft	54 ft. 3 in.
Underlying clay.	

As an illustration of the comparative cheapness of shafts sunk in this formation, for air or pumping purposes, it may be mentioned that this fifty-four-foot shaft was sunk for $50, and an offer was made, but not taken, to sink one a hundred feet deep for $75. The refusal of the offer was based on the opinion that too much was asked for the work contemplated. The cost of the fifty-four-foot shaft may be estimated as the cost of sinking a like number of feet anywhere in this formation.

BUTTE COUNTY.

This county derives its name from that singular elevation known as the "Sutter Buttes," standing in the northwestern corner of Sutter County, near the line of Butte. This elevation, which consists of three isolated peaks, springing up from a short range of mountains, is sometimes called "Marysville Buttes," and forms a conspicuous object in that section of country. Butte County is bounded on the north by Tehama, on the east by Plumas, on the southeast by Yuba, on the south by Sutter, and on the west by Colusa.

The surface of this county consists of valleys, plains, and hills, the Sacramento Valley occupying its more central portion. Its principal streams are the Feather River, with its three main forks, the Little and Big Butte Creeks in the east, Chico Creek in the south, and various smaller streams in the western part. The plains and valleys are sparsely timbered with white oak, the hill districts being covered with a heavy growth of pine, cedar, etc.

MINERAL RESOURCES.

Butte is the only county in the State showing an almost equal importance in an agricultural and a mining point of view, as nearly every branch of agriculture is here represented; so is every kind of gold mining successfully pursued, quartz, hydraulic, drift, and river bed operations being all successfully prosecuted, the latter on a large scale.

The Big Bend Tunnel, constructed for draining the bed of the Feather River, is not only the largest enterprise of the kind in California, but the largest probably ever undertaken for a similar purpose. The operations of the Spring Valley Hydraulic Company, at Cherokee, in this county, are also among the largest now carried on in the State. In this locality, too, was picked up a majority of the more valuable diamonds found in California. In Butte, the pliocene river system, the principal sites of the drift mines, meets with its greatest development. This county has in the past been a large producer of the royal metal, and, to use a scriptural expression, "the gold of that land is good," much of that obtained from the placer mines having ranged from 945 to 980 in fineness.

Several of the useful minerals also occur in this county; some of them under conditions that promise to render them of much economic value. Coal, claimed to be of the Cannel variety, was discovered some years ago near Feather River. Having been but little opened, neither the extent of this deposit nor its value as a fuel has been ascertained. Near the same river has been found a bed of marble of close texture and variegated hue, but it also remains unopened, with not much known in regard to its value. Clays, suitable for making bricks, and perhaps those of a finer kind, are plentiful in Butte.

DRIFT GRAVEL MINES.

BAY STATE MINE.

This mine is situated on the east side of Big Butte Creek, one and one fourth miles southwesterly from the town of Nimshew, and at an altitude of about two thousand feet above sea level. The property owned by a Maine company includes an area of one hundred acres. The course of the channel is northeast and southwest; width not ascertained.

The mine is opened by two tunnels, one being three hundred feet long, in slate, the other, two hundred feet long, in granite. The gravel is free. Drifting has but lately been commenced; nothing can be said as to its depth or value, except that results so far are reported satisfactory. The gold obtained here is worth $18 per ounce.

EUREKA MINE.

This property, which covers an area of two hundred acres, is located in the Magnolia Mining District, in the northwestern part of the county, and at an altitude of twelve hundred and fifty feet. The course of the channel is a little east of north and west of south, the latter down stream. The mine is worked through a tunnel twelve hundred and fifty feet long, driven through a slide of lava and slate. The gravel here is of the variety known as "blue." With little exception it is not cemented, nor is it much washed, containing many angular or subangular fragments. The bedrock is slate; width of channel, so far as ascertained, from fifteen to forty feet. The stratum of gravel removed varies from two and one half to three feet in thickness, twenty-two carloads, of one ton each, being taken out daily. The value of this material is not uniform; while some of it yields as much as $16 per carload, the average yield is greatly less. Owing to there being a lava roof, but few posts are required to support it, the timber used for this purpose being spruce and pine; cost, 8 cents per running foot. The bowlders found in this "Dead River" channel consist of quartz and slate, with a few of granite. The channel here makes but little water.

At this mine, which has been worked for the past four years, ten men are employed, at $2 per day, with board. As yet not much has been done beyond completing the tunnel and breasting out for a width of about twenty-five feet. The output to date is about $30,000. Most of the gold is coarse, some nuggets worth as much as $80 having been taken out; assay value, $18 25 per ounce. Much black magnetic and gray sand are found mixed with the fine gold. Most of the latter is lost, as no quicksilver is used in the sluice. Ventilation here is secured by a water blast. For gravel washing the water is obtained from the mine, supplemented by a quantity brought through a two and one half-mile ditch from Middle Butte Creek.

Altitude	1,450 feet.
Course of channel	Down stream, west of south.
Length of tunnel	1,250 feet.
Cost of tunnel, per foot	Not given.
Nature of pay gravel	Free.
Nature of bedrock	Slate.
Depth of gravel drifted	2½ to 3 feet.
Extent of claim	200 acres.
Length of time worked	4 years.
Number of men worked	10
Wages paid	$2 per day, with board.
Total output to date, about	$30,000

MAGALIA CONSOLIDATED.

This claim, located one and a quarter miles northwest of the town of Paradise, and better known as the Mineral Slide, comprises an area of several hundred acres. The course of the channel here is northeast and southwest. Altitude, one thousand eight hundred feet.

The mine has been exploited by two tunnels, the upper eight hundred and the lower three hundred feet in height. Cost of driving, $3 per linear

foot; material penetrated, gravel; bedrock, sandstone; depth of gravel, fifteen to twenty feet; stratum extracted, four feet. The channel at this point is lava capped, and is supposed to be underlaid by another and similar channel not yet explored. No water or bowlders have yet been encountered in the workings. Spruce and pine, for timbering, are obtained from the neighboring hills, some of it being sent down through a chute. Cost of timbering, 4 cents per running foot. The channel here is forty feet wide.

The gravel, which is free, or but little cemented, pays from $1 to $1 25 per carload of half a ton, sixty-five carloads being taken out per day. A total of eleven men are employed here, at $2 50 per day each, with board. The gravel extracted from this part of the channel is rounded, showing it to have been much water-worn. The gold is not generally coarse, the largest piece taken out being worth only $13 20. It sells at the rate of $18 65 per ounce.

Water for sluicing is brought in through a short ditch from Little Butte Creek. The quartz sometimes contains visible gold.

Altitude	1,800 feet.
Course of channel	Northeast, southwest.
Width of channel	40 feet.
Length of tunnels	1,100 feet.
Cost of tunnels	$3 per foot.
Nature of gravel	Free.
Nature of bedrock	Sandstone.
Depth of gravel drifted	4 feet.
Pay	$1 to $1 25 per (half ton) carload.
Length of time worked by present party	5 months.
Number of men employed	11
Wages paid	$2 50 per day, with board.

ORO FINO.

This mine, which is located two and a quarter miles north from the town of Nimshew, at an altitude of two thousand three hundred and forty feet, contains eighty acres. It occurs in slate and serpentine, and is lava capped; course of channel, south of east and north of west, the latter being down stream. The mine is worked by means of a tunnel, driven five hundred feet through serpentine, at a cost of $3 per linear foot. The gravel is drifted out to a depth of fifteen feet, and yields $5 to the carload of one thousand eight hundred pounds, eight carloads per shift being taken out by each man.

The pay gravel, which is overlaid by a bed of tufa, has a width of fifty feet, and the breasts all require timbering. Few bowlders occur here, and no water. For gravel blasting Giant powder, No. 2, is used. In practice a cavity one and one half feet to two feet deep is made by means of small steel bars called "moils." In these cavities powder is placed, in the proportion of one pound to three feet of depth, and exploded without tamping, each blast so breaking up a large amount of gravel that it can easily be removed. Every pound of powder so applied equals the services of one man. Through the economy of labor here effected, gravel that yields but 25 cents per car will pay expenses. When the gravel is much indurated, as occasionally happens, drills have to be employed in making the cavities for the reception of the powder. This impacted material, or cement, on being exposed to the atmosphere gradually "slacks," as the miners term it, undergoing, after a time, such thorough disintegration that most of the gold can be separated from it and saved by sluice washing. Mixed with

this gold is much black sand. Timber suitable for supports is found here, growing on the company's ground. There are employed in this mine ten men at $2 per day and board.

The gold taken out is coarse and worth $18 25 per ounce. There is another Oro Fino drift mine three miles further down Butte Creek; but on this so little work has been done that it requires no further mention.

Oro Fino Drift Gravel Mine.

Altitude	2,340 feet.
Extent of claim	80 acres.
Course of channel	South of east, north of west.
Length of tunnel	500 feet.
Cost of tunnel	$3 per foot.
Nature of pay gravel	Free.
Nature of bedrock	Serpentine.
Depth of gravel drift	15 feet.
Pay	$5 per car.
Width of channel	50 feet.
Length of time worked	8 months.
Number of men worked	10
Wages paid	$2 per day, with board.

THE LUCRETIA MINE.

This mine, known also as the Perschbecker, is situated on Little Butte Creek, three miles northwest of Magalia, at an altitude of two thousand five hundred and fifty feet. The claim, which for many years has been a large gold producer, a total of more than $1,000,000 having been taken out, is opened by a tunnel eight hundred feet long, and a six hundred-foot incline put down from its inner extremity to a depth of two hundred feet below the tunnel level. For the lifting and pumping services a steam hoisting works has been erected at the mouth of the tunnel. After having been suspended for several years by reason of legal difficulties, operations have lately been resumed and are now being actively prosecuted, and with the usual good results.

THE AURORA.

This property, owned by eastern parties, is situated in the Magalia District, at a point three and one half miles north from the town of that name.

The ground is opened by a shaft ninety feet in depth, from the bottom of which a one thousand three hundred-foot tunnel has been driven to the gravel, traversing a serpentine and slate formation, which constitutes also the bedrock. At first operations were carried on here in small irregular channels. Afterwards a large regular channel was found and opened, this being the one now worked, and to which the others are tributaries. This channel, which has an average width of twenty feet, lies under a mass of superimposed volcanic matter. The gravel, which is free and somewhat angular, contains but little quartz, being composed mostly of serpentine and slate. The gold found here, though coarse and of good color, commands only $17 50 per ounce. Many bowlders are encountered in the drifts—the larger a blue slate, the smaller mostly quartz. There occurs here also much red jasper and magnetic black sand, the latter auriferous.

In regard to the relative positions of the several mines described, it may be observed that while the Aurora and the Lucretia are working down stream towards Big Butte Creek, the Oro Fino, Mineral Slide, and some others are working up stream in the direction of Little Butte Creek. While these various channels are each marked by certain characteristics, the gravel in all consists mainly of the adjacent country rock, and is but little

water-worn. Although the gold in some is coarse, and in others fine, some carrying red jasper, and others not, it is not an easy matter to identify these several channels at different points.

Altitude	2,625 feet.
Area of claim	160 acres.
Course of channel	Southwesterly—down stream.
Depth of shaft	90 feet.
Length of tunnel	1,300 feet.
Nature of pay gravel	Free.
Depth of gravel drifted	3 feet.
Width of channel	20 feet.
Nature of bedrock	Slate and serpentine.
Length of time worked by present party	1½ years.
Quantity of water	6 miner's inches.
Kind of pump used	Dow.
Horse power of engine for pumping and hoisting	40
Cost of wood for fuel	$2 50 per cord.
Number of men worked	25 to 30
Wages paid	$2 per day, with board.

INDIAN SPRING MINE.

This mine is located five miles northwest of Dogtown, on a ravine cutting into Butte Creek. It has been worked at intervals for the past twenty-five years, and is still making a small production, the working force consisting of four men. The stratum of gravel removed here has a thickness of about three and one half feet, and carries a fair percentage of gold.

QUARTZ MINES.

While quartz mining has never been very extensively carried on in Butte, it has, for many years, formed one of her subordinate mining industries, the most notable quartz mining localities being Forbestown, Wyandotte, Cherokee, Brown's Valley, Merrimac, Yankee Hill, Inskip, and Oregon City. There are eleven mills in the county, carrying a total of about one hundred stamps, or their equivalent, the most of which are kept running.

At Forbestown, the Golden Bank Company has exploited their lode by means of a shaft two hundred feet deep, connected with which is a tunnel five hundred feet long, run in the vein, which varies from four to six feet in width. Hoisting works, operated by water obtained from the Forbestown ditch, have been erected on the mine, also a Huntington crusher, having a daily capacity of thirty-five tons. The ore carries a large percentage of rich sulphurets, for the treatment of which suitable works are soon to be put up.

On a quartz lode two miles northwest of Merrimac, a Huntington crusher and a ten-stamp mill are being operated, the former on the Golden Eagle Mine. Another ten-stamp mill is being put up there. Although no great amount of exploratory work has been done at this point, the prospects are encouraging.

On the Golden Queen Mine, near Forbestown, several short tunnels have been run and some crosscutting done, with such good results that the owners contemplate putting up a twenty-stamp mill on the property.

The Shakespeare Mine, one half mile south of Forbestown, and the Mount Hope, four miles east of that place, are both being prospected and show good indications of future value.

At Inskip, in the northeastern part of the county, several quartz veins are being opened by means of shafts, none of which are over one hundred feet deep. The veins, which occur in slate and granite, vary from one and

one half to eight feet in thickness. The ore looks well, and there is much rich float on the hills in the vicinity. As there are good facilities at hand for working these lodes, water and timber being abundant in the district, they would appear to have a promising future.

At the other quartz mining camps in this county there is but little work in progress, though at most of them there are signs of approaching activity.

THE BIG BEND TUNNEL.

In the annual report of the State Mineralogist for 1886, appears a brief description of this formidable undertaking. The work of enlarging the tunnel then in progress was, in the month of September, 1887, brought to completion, its height having been increased from nine to thirteen feet, its width, sixteen feet, remaining as before. With such increment of size this tunnel has shown itself capable to receive and carry the entire flow of Feather River during the lower stage of that stream, the only time when it is proposed, or indeed, possible, to work the river bed. Before this enlargement had been effected, the season was too far advanced to admit of operations being commenced last year.

With the advent of low water the past summer, the river having been turned into the new tunnel, the extraction of auriferous gravel from its drained channel was begun, and at the end of September was still in progress, having been carried on with the utmost vigor, and, as we are advised, with satisfactory results.

Meantime, the main head dam has been finished, the electric plant, designed for working the pumps and derricks, and for illuminating the river bed at night, has been put in place, and the whole vast enterprise put in shape for efficient and successful operations. In consummating a work of such magnitude, its projectors and promoters are to be congratulated, and it is much to be hoped that their enterprise and perseverance will meet with due appreciation and large reward.

CALAVERAS COUNTY.

There is some difference of opinion as to the origin of the name of this county, which, in the Spanish, signifies skulls. It is by some claimed that the native Californians, during a hostile incursion into that part of the country, came upon a spot containing a large number of human skulls, the probable site of a former Indian conflict. Others incline to the belief that some devout friar, desirous of commemorating the crucifixion, slightly changed the name Calvary, and gave it to this locality.

Calaveras County is bounded on the north by Amador, on the east by Alpine, on the southeast and south by Tuolumne, and on the southwest and west by San Joaquin County.

Commencing in the low undulating prairies of the west, the surface of this county gradually rises into the foothills of the Sierra Nevada, culminating finally at the summit of that range, the topography conforming in its general features to that common to most of the central mining counties. The lower part of this county is comparatively timberless, the central and upper portions being covered with splendid forests of pine, spruce, and cedar. Near the center of the county, at an elevation of about four thousand seven hundred feet, stands the grove of *sequoia gigantea*, known as the Calaveras Big Trees, the most remarkable example of tree growth probably in the

world. At the same elevation occur great numbers of sugar pine, growing to an immense size and furnishing the finest lumber found in California. Excepting the Calaveras River, which flows across its central portion towards the southwest, this county is without large streams, though there are in many parts of it, more especially in the mountains, many creeks, some of which, during the wet season, are swollen into considerable streams. The Mokelumne River, on the northwest, separates Calaveras from Amador County, while the Stanislaus, on the southeast, separates it from Tuolumne.

While Calaveras is not without agricultural resources, it is essentially a mining county, gold mining being here pursued in nearly all its forms. The principal mining localities are Angels, Copperopolis, Milton, Murphys, Mokelumne Hill, Campo Seco, Sheep Ranch, Altaville, West Point, and Rich Gulch, there being, besides these, many smaller camps and hamlets. A great deal of money has been expended in Calaveras in the construction of water ditches and wagon roads, the county being well supplied with the latter. Besides being notably rich in gold, Calaveras possesses large and valuable copper mines and deposits of iron ore, limestone, marble, sandstone, etc.

THE UTICA MINE.

This mine is situated in the town of Angels, and its course is northwest and southeast. The vein is nearly vertical, the slight variation of the vein from the perpendicular being easterly, and its average width twenty-five feet. The dimensions of the claim are six hundred and thirty-four feet by three hundred, and the length of the shoot four hundred feet. The mine is opened by a shaft, which is nearly vertical, and four hundred and twenty-five feet in depth. The hanging and foot-walls of this mine are, like those of the adjoining mines, diorite (greenstone) and talcose slate, respectively. The mine yields about fifteen thousand gallons of water daily. No pump is used, but about one hundred water barrels, holding about one hundred and fifty gallons each, are raised per day. The Rix & Firth compressor and three National drills are used. One thousand five hundred pounds of Safety Nitro powder, No. 2, are consumed monthly, and about one hundred pounds of drill steel. The shaft, which is four feet by eight in the clear, and has two compartments, cost from $16 50 to $17 per foot, and about two feet were sunk per day, the shaft being in ledge matter to its extreme depth. All of the shaft was timbered, but the ground was heavy, and on taking out a pillar of ore near the shaft, during the past summer, a cave occurred, causing a temporary stoppage of ore extraction and milling; but the ground was "caught up" and the shaft repaired as soon as possible, and another main working shaft, north of the one described, commenced at once, five by twelve in the clear, having three compartments, two of them four by five feet each, and a ladder-way compartment three by five, ten by twelve-inch sawed timbers being used, except for center braces, which are six by twelve inches. Sawed timber, which is hauled about twenty miles, costs $20 per thousand, and round timbers, which are used in levels and stopes, cost 18 cents per running foot. The ore is raised from the mine and discharged directly into the ore bins of the mill. The ore is crushed and pulverized in a stamp mill, and amalgamated in the batteries and on outside plates. The sulphurets are recovered on eight Frue concentrators. Chrome steel shoes and iron dies are employed, the steel costing 8 cents per pound, and the iron 4½ cents, the steel lasting ten months, or during the crushing of fifteen thousand tons of ore, the iron lasting three months, or during the crushing of four thousand five hun-

dred tons. In other words, fifteen thousand tons of ore consume two thousand eight hundred and sixty pounds of steel, or nineteen one hundredths pound per ton of ore crushed. With steel at 8 cents per pound, the wear of shoes is 1.5 cents per ton of ore milled. While about two thousand four hundred and sixty pounds of iron dies are consumed in milling about four thousand five hundred tons of ore, or fifty-five one hundredths pound of iron, at 4½ cents, equivalent to 2.5 cents for iron dies consumed for each ton of ore milled, making the total wear of shoes and dies 4 cents per ton. The use of steel shoes and iron dies is owing to the belief that a more smooth and less rapid wearing will result. Steel shoes have the recommendation of requiring less change, resulting in a saving of running time, and iron dies with steel shoes are thought also to break less readily than steel. About seven and one half inches of water are used in the batteries. The screens are made of tinned iron, the tin being burned off previous to use, and are round punched, No. 0, corresponding to about No. 9. It is thought that these screens are particularly adapted to the discharge of pulp of certain degrees of fineness. The screens are slightly inclined, and, inside of the frames, are six by forty-eight inches. The outside plates are silvered, and have an inclination of one and one fourth inches to one foot. It is stated that the average bullion is 880 fine in gold. The hoisting machinery and compressor are run by steam. The mill is run by water power, with a pressure of ninety-eight feet, or by steam, in case of failure of water supply. For the hoisting works a ten by twenty-inch double engine is employed, and seven eighths-inch steel cable. The mill requires, for power and batteries, one hundred and eighty inches of water daily, for which 8 cents per inch is paid. The developments consist of one level, at one hundred and forty feet in depth, having a length of six hundred feet, and another three hundred feet in length, three hundred and forty-five feet from the surface. The improvements consist of the new tripartite vertical north shaft now being sunk, and the north hoisting works rapidly approaching completion, the gallows frame of which is one of the highest in the State. The works generally are very complete in detail. New hoisting works are now being constructed on the south shaft, with the same dimensions as those of the other. Forty stamps more are being added to the mill, and sixteen concentrators, making in all sixty stamps and twenty-four concentrators in the mill, which is the largest one in this county. Mining and milling costs will in future be reduced. The cost of milling at present, with twenty stamps, is as follows: Labor, per ton, 45 cents; water, 29 cents; steel shoes, 1.5 cents; iron dies, 2.5 cents; incidentals, screens, quicksilver, lights, taxes, insurance, etc., 7 cents; total cost of milling, 85 cents per ton.

Altitude (aneroid reading)	1,400 feet.
Length of ore shoot	400 feet.
Depth of ore shaft	425 feet.
Vertical depth reached in mine	425 feet.
Quantity of water raised in twenty-four hours	15,000 gallons.
Character of hanging-wall	Diorite (greenstone).
Character of foot-wall	Talcose slate.
Kind of powder used	Safety Nitro, No. 2.
Quantity of powder used	1,500 pounds monthly.
Cost of mining	$1 50 per ton.
Cost of shaft	$16 50 to $17 per foot.
Number of feet timbered	425
Kind of timber	Yellow pine.
Cost of timber	Sawed, $20 per 1,000 feet; round, 18 cents per linear foot.
Character of ore	Free milling with sulphurets.
Character of works	Stamp mill, water and steam power.
Number of stamps	20*

*This number has been increased to 60.

Weight of stamps	900 pounds.
Drop of stamps	5 inches.
Height of discharge	6 to 10 inches.
Drops	100 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	Steel shoes, iron dies.
Size and character of screens	Round punched, No. 9.
Water used in battery	7 to 8 inches.
Dimensions of apron	4 by 24 feet.
Width of sluice	Apron and sluice the same.
Length of sluice	Apron and sluice the same.
Kind of feeder	Challenge.
Kind of concentrators	Frue's.
Percentage of recovery saved in battery	60
Percentage of recovery saved on plates	40
Percentage of sulphurets	1½
Value of sulphurets	$40 to $50 per ton.
Cost of milling	85 cents per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	9, including foreman.
Number of men in mine	16
Number of men outside	4
Total number employed	29
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$2 00 per day.
Cords of wood used per day	2 at hoisting works and for compressor. 3½ when mill is run by steam.
Cost of wood	$4 per cord.
Quantity of water used in milling	7½ inches.
Head of water used for power	98 feet.
Fall of water used for power	180 inches.
Cost of water for milling	60 cents per day.
Cost of water for power	$13 80 per day.

THE STICKLES GOLD QUARTZ MINE.

This property is situated in the town of Angels. The general trend of the vein is north of west and south of east with an easterly dip, but with so slight an angle from the perpendicular that a vertical shaft sunk four hundred feet in the vein matter has not yet reached the wall. The average width of the vein may be stated as twenty feet, but it varies from ten to fifty. The dimensions of the claim are six hundred and fifty feet by three hundred, and two ore shoots are now being worked, with a reef of slate of about fifty feet in length between them. The entire length of the shoots has not as yet been determined; present development shows a distance of two hundred and twelve feet between the extreme points of exploration, with a tendency into the Utica, an adjoining mine, in one direction, and a continuation on the opposite end as well. The vertical shaft, already alluded to, is the only one by which the mine is opened; it has three compartments, and is four and one half feet by thirteen in the clear; twelve inch square timber is used throughout with the exception of the center-braces, which are eight by twelve inches; the sets are placed six feet apart. The hanging-wall is diorite (greenstone) and the foot-wall is talcose slate. An eight-inch Cornish pump, running at the rate of five strokes per minute, with a six-foot stroke, frees the mine of water. The Rix compressor and Ingersoll eclipse drill are employed, and from one thousand to one thousand two hundred pounds of Giant powder, No. 2, are consumed monthly. The cost per pound is 16 cents delivered at the mine. Although the vein has great width, square sets of timber are not employed, the ground simply being "stulled" with twenty-inch round, yellow pine timber, costing here 18 cents per running foot, it being twenty miles from the mine to timber. The company constructed and laid to their works six thousand and fifty

feet of pipe, with diameters twelve and eighteen inches. The ore is transported from the hoisting works to the mill over a tramway furnished with twelve-pound "T" rails. The ore is treated in a water-power stamp mill, driven by a six-foot Donnelly wheel under a head of two hundred and fifty feet. Quicksilver is used in the battery, but no copper plates are employed for amalgamating inside; most of the gold is caught on the outside plates, which are silvered and have an inclination of about one inch to one foot. The sulphurets are recovered in riffle sluices, and subsequently "buddled" and worked at Custom Chlorination Works, near Angels. Steel shoes and dies are employed, costing 9 cents per pound, and are said to last one year. In other words, on this assumption about six thousand pounds of steel are consumed during the crushing of about one thousand eight hundred tons of this ore, equivalent to one third of a pound of steel per ton of ore crushed, representing an expense of 3 cents per ton. About six inches of water are required for use in the batteries. The screens used are No. 50 brass wire, six inches wide and forty-nine inches long, inside the frame, placed vertically. Below the aprons, which are four by fourteen feet in size, there are two sluices to each battery, which are fifteen inches wide and ten feet long. The machinery at the hoisting works consists of a steam engine twelve inches by twenty-four, connected with a tubular boiler four feet in diameter and sixteen feet in length; another steam engine, twelve inches by twenty-four, for driving the pump, but not used excepting in case of a failure of water power. The pump is usually run by water power applied to a five-foot Donnelly wheel; the compressor is run with a six-foot Donnelly; the pump and compressor together requiring fifty inches of water. Three-inch flat wire cable is used in hoisting; the ore is brought out of the mine in cars, placed on the cage, which, on reaching the surface, are run to the mill by a carman.

The developments other than the shaft mentioned consist of four levels, one at every one hundred feet, stations and ore bins at each level on the hanging-wall side of the shaft: No. 1, one hundred feet deep, is eighty feet long, running south; No. 2, two hundred feet deep, is one hundred and sixty feet long, running south, and two hundred and forty-nine feet long, running north; No. 3, three hundred feet deep, is one hundred and twenty-three feet long, running south, and eighty feet long, running north; No. 4, four hundred feet deep, is two hundred and twelve feet long, running south, and one hundred and seventeen feet long, running north.

During the last year the south drift on the four hundred level was run one hundred and fifty feet, and the north drift one hundred feet; the south drift on the three hundred-foot level was extended fifty feet. It is proposed to add twenty or thirty more stamps to the mill and equip it with Frue vanners. It is also in contemplation to lay about eight hundred feet of pipe that will give sixty feet more fall, and to resume sinking of the shaft as soon as it can be done to advantage.

Cost of milling: Per ton, labor, $16\frac{1}{2}$ cents; water, $10\frac{8}{10}$ cents; shoes and dies, 3 cents; screens, $\frac{7}{10}$ of a cent; incidentals (quicksilver, taxes, insurance, etc.), 9 cents; total, 40 cents.

The entire cost of mining, milling, and transportation, including dead work, does not exceed $2 50 per ton.

Altitude (aneroid reading)	1,400 feet.
Length of ore shoot	212 feet.
Depth of ore shaft	400 feet.
Vertical depth reached in mine	400 feet.
Quantity of water raised in twenty-four hours	50,000 gallons.
Character of hanging-wall	Diorite (greenstone).

Character of foot-wall	Talcose slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used	1,000 to 1,200 pounds monthly.
Cost of mining	$2 05 per ton.
Number of feet timbered	400
Kind of timber	Yellow pine, round and square.
Cost of timber	$20 per thousand feet for sawed; 18 cents per running foot for round.
Cost of transport of ore	5 cents per ton.
Character of ore	Soft, free milling.
Character of works	Water power stamp mill.
Number of stamps	20
Weight of stamps	950 pounds each.
Drop of stamps	6 to 8 inches.
Drops	86 per minute.
Duty of stamps	2½ tons in twenty-four hours.
Height of discharge	8 inches.
Kind of shoes and dies	Steel from Pacific Rolling Mills.
Size and character of screens	Brass wire, No. 50.
Water used in battery	6 miner's inches.
Dimensions of apron	4 by 14 feet.
Width of sluice	15 inches.
Length of sluice	10 feet—two to each battery.
Kind of feeder	2 Roller and 2 Challenge.
Kind of concentrators	Riffle sluices and Cornish buddles.
Percentage of gold recovered in battery	33⅓
Percentage of gold recovered on plates	66⅔
Percentage of sulphurets	2
Value of sulphurets	$65 to $70 per ton.
Cost of milling	40 cents per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	3
Number of men in mine	22
Number of men employed on outside work	5
Total number employed, including foreman	30
Average wages in mine	$2 50 per day.
Average wages in mill	$2 75 per day.
Average wages paid outside work	$2 per day.
Wood used	¾ of a cord per day.
Cost of wood	$4 per cord.
Quantity of water used for mill power	60 miner's inches.
Head of water used for power	250 feet.
Quantity of water used for power for pump and compressor	50 inches.
Cost of water for mill power	9 cents per inch, $5 40
Cost of water for power	9 cents per inch, $4 50

THE SUFFOLK GOLD QUARTZ COMPANY.

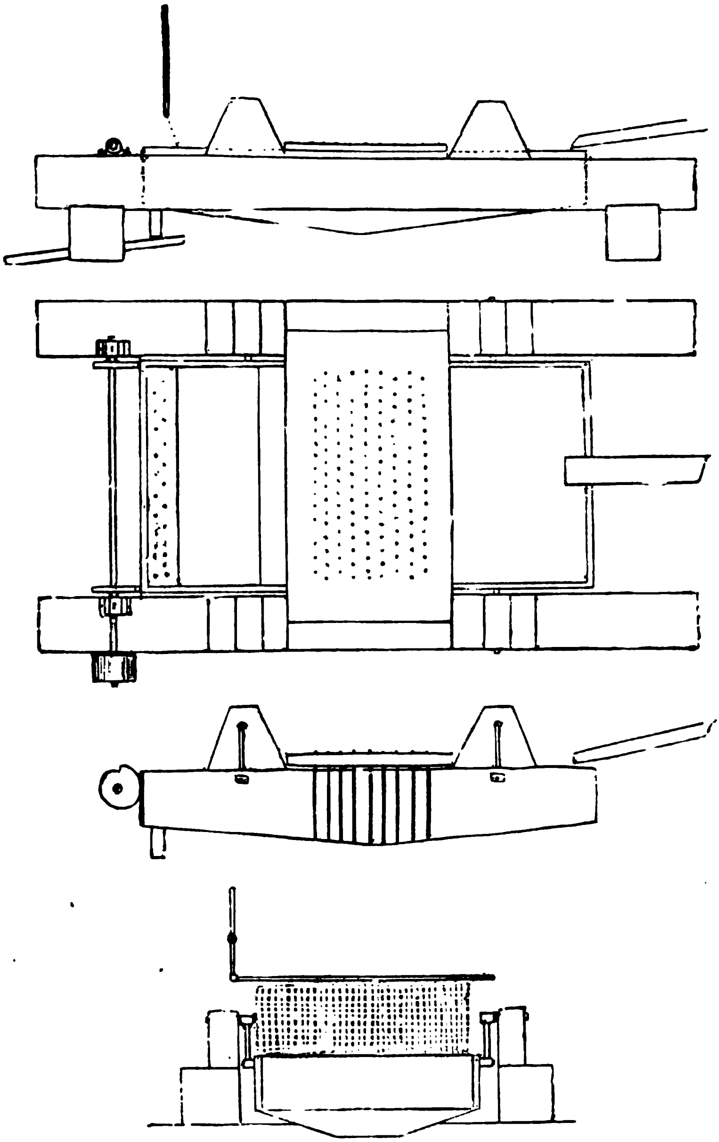
This company operates the Smyth Mine, a location of 1878, situated in the Angels Mining District, about midway between Angels and Altaville, about one mile west of the Post Office at Angels. The course of the vein is northwest and southeast, the dip northeasterly at an angle of 50 degrees. The vein has an average width of about four feet, the claim itself being two thousand five hundred by six hundred feet, and the ore shoot about seventy feet in length. Two shafts and a tunnel have been commenced for prospecting work, the tunnel being driven two hundred and eighty feet, reaching a vertical depth of eighty feet below the surface, and one shaft reaching one hundred and ten feet, measured on an incline of 50 degrees, and another being fifty feet perpendicular and thirty feet on the incline. The hanging-wall is diorite (greenstone) and the foot-wall is talcose slate. The shafts are not connected, and each yields about seven thousand gallons of water per day, and each is provided with a double-acting Excelsior pump, with three-inch cylinder. The discharge pipe of one of the pumps is one and one fourth inches in diameter, of the other, two inches. Single hand three fourths inch drills are used, and fifty pounds per month of Vulcan powder, No. 2. The cost of sinking the shafts, one four by four feet, the other four by six feet in the clear, was $12 per foot, without timbers.

One shaft was sunk one hundred and ten feet through diorite, and the vein was reached by drifting; the other, after passing fifty feet through diorite, was sunk in vein matter. The shafts are timbered with eight by eight-inch sawed pine timber, placed at the usual distance apart (five feet from center to center). The sawed timber is delivered at the mine for $20 per thousand, while round timbers, from eight to twelve inches at the smaller end, cost from 10 to 12 cents per running foot. The timber has to be hauled about twenty miles. The ore is run over a tramway from the mine to the mill, by use of a car and carman, and the expense of transportation is 20 cents per ton. The ore is free milling, with a very large percentage of sulphurets of various kinds, including copper pyrites. Considerable gangue on the foot-wall is gold-bearing, and carries sulphurets. One character of ore seems to be a gold-bearing talc, another a mixture of diorite (greenstone) carrying free gold, and highly charged with sulphurets. The ore is sometimes amalgamated in the battery, and sometimes not, according to the nature of the rock; in either case the amalgamation is on outside electroplates, and afterward in a shaking table of peculiar construction, and illustrated in the accompanying drawings. Sometimes some of the ore is worked in a kind of arastra, but usually amalgamation is completed on the shaking table, which has a silvered plate on the discharge side, on which a spray of water strikes.

The mill contains five stamps, of six hundred pounds each, which are given a drop of from four to six inches, eighty times per minute. The mill has a capacity of crushing ten tons in twenty-four hours. The shoes and dies are white iron. Three hundred tons of ore wear out about four hundred pounds of iron, representing a weight of one and one third pounds of iron to the ton of ore crushed. At 4½ cents per pound for iron the wear of shoes and dies is 6 cents per ton of ore crushed, the lightness of wear indicating a soft rock. The battery requires about one miner's inch of water. Nos. 9 and 10 angle slot screens, six by forty-four inches inside the frame, are set vertically. The discharge is four inches above the die, and increases to seven. The apron is forty-eight by fifty-four inches; the sluice eight inches in width and twenty feet long, inclined one and one half inches to one foot, and silver-plated. Two plates are used inside of the battery, one on each side, forty-four by three inches, and forty-four by six inches, respectively. The Stanford self-feeder is used. When the ore is amalgamated in the battery, 60 per cent of the value recovered is saved inside, about 25 per cent on outside plates, and 15 per cent on shaking table, though for one month one third of the gold was saved in each place. The percentage of sulphurets varies from one to ten, principally iron and copper pyrites, associated with arsenic. They have a value of about $50 to $100 in gold, and $1 50 silver by assay, and are saved in riffle sluices. They are worked at chlorination works, where 90 per cent of the assay value is allowed, and $20 is charged for treatment.

The number of men employed in the mine, including foreman, is five; in the mill, two; outside, two; total, nine. Wages per day, in the mine, $2 50; in the mill, $3 and $2 50; the blacksmith and foreman receive $3. One twenty-eight-foot overshot wheel runs five stamps; one twenty-four-foot overshot wheel runs crusher and one pump; one twelve-foot overshot wheel runs the other pump. Forty inches* runs every wheel, some of the water being used successively. The water is sold at 10 cents per inch, the total cost being $4 per day for all purposes. About one half is used for the mill. The

*A four-inch pressure above a four-inch slot is local measurement here of the miner's inch.



Shaking Table, Invented by Charles V. Smyth. (Used at the end of mill sluice.)

developments, besides the tunnel and shafts, consist of a fifty-foot level in one shaft, with southeast drift seventy-four feet long; and a drift, at eighty feet, about sixty feet long; and at one hundred and ten feet, on the other shaft, a drift on the vein one hundred and forty-five feet in length. It is proposed to put in five additional stamps, and Frue vanners, some time in the near future.

Cost of milling per ton: Labor, 55 cents; water, 20 cents; shoes and dies, 6 cents; incidentals, 29 cents; total, $1 10.

Altitude (aneroid reading)	1,600 feet.
Length of ore shoot	70 feet.
Length of ore shaft on incline	80 feet.
Depth reached by ore shaft vertically	76 feet.
Quantity of water used in twenty-four hours	6,000 to 7,000 gallons.
Character of hanging-wall	Diorite (greenstone).
Character of foot-wall	Talcose slate.
Kind of powder used	Vulcan, No. 2.
Quantity of powder used	50 pounds per month.
Cost of tunnel (without timber)	$3 to $4 per foot.
Cost of shaft (without timber)	$12 per foot.
Number of feet timbered	All.
Kind of timber	Sawed yellow pine.
Cost of timber	Sawed, $20 per M.; round, 10 to 12 cents per running foot.
Cost of transport of ore	20 cents.
Character of ore	Soft free milling, with sulphurets.
Number of stamps	5
Weight of stamps	600 pounds.
Drop of stamps	4 to 7 inches.
Drops	80 per minute.
Duty of stamp	2 tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Angle slot, Nos. 9 and 10.
Water used in battery	About 1 inch.
Dimensions of apron	48 by 54 inches.
Width of sluice	8 inches.
Length of sluice	20 feet.
Kind of feeder	Stanford.
Kind of concentrators	Riffle sluices.
Percentage of recovery saved in battery	60
Percentage of recovery saved on plates	25
Percentage of gold saved on shaking tables	15
Percentage of sulphurets	1 to 10
Value of sulphurets	$50 to $100 per ton.
Cost of milling	$1 10 per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	2
Number of men in mine	5
Total number employed	9
Average wages in mine	$2 50 per day.
Average wages in mill	$3 and $2 50 per day.
Average wages paid outside work	$2; blacksmith, $3 per day.
Quantity of water used in milling	2 inches.
Head of water used for power	Use overshot wheel; diameter of overshot, 28 feet.
Cost of water for milling	20 cents per day.
Cost of water for power	$3 80 per day.

THE M'CREIGHT MINING COMPANY.

This company's property, also known as the Tryon Mine and Mill, lies three miles southeast of the town of Angels, and has a general course nearly southeast and northwest, with easterly dip at an angle of about 45 degrees, and an average width of about eight feet. The dimensibns of the claim are four hundred and fifty feet by three hundred, and six hundred and twenty-five feet by about six hundred feet, with developments consisting of an incline shaft eighty feet in depth, and a tunnel about three hundred and fifty feet long, nearly all of the distance following the vein. The hanging-wall is diorite, usually called in this locality "gray greenstone," and the foot-wall is talcose slate. This mine is singularly free from water, and scarcely affords enough, at present depth, for drilling purposes. As the ground is hard, very little timber, which is hauled about twenty-three miles, is required, only about forty feet being timbered in each shaft and tunnel. The ore is dumped from the tunnel cars into an ore bin, then transported by horse and cart to the mill. The ore, though free milling, contains about 5 per cent of sulphurets, which are both coarse and fine, but of small value. Amalgamation is performed in the battery and on outside plates, and experiments are being made with a Frue concentrator, having a corrugated

belt. Inside of the battery copper plates are used and on the outside electroplates. Formerly iron shoes, and dies costing 4½ cents per pound, were used, and the shoes lasted about sixty days and the dies forty-two. Experiments are now being made with chrome steel, but comparative results have not been obtained. With the use of iron for shoes and dies the wear of the die is about one and ninety-eight hundredths pounds to one ton of ore crushed, while the wear of the shoe is about one and fifty-two hundredths pounds; for shoes and dies both, three and a half pounds, which is equivalent to 15¾ cents. Lessening this amount by ¾ cent for old iron returned, it would seem that on this ore shoes and dies cost 15 cents for each ton milled. It is four inches from the top of the die to the discharge, when the dies are first placed, if fine screens are used, and the dies are worn down until the discharge is about seven inches above the die. The dimensions of the screens inside of the frame, which is vertical, are about six inches by forty-two. The plate used inside of the battery is about six inches by forty-six inches. The outside plates, which are silvered, have an inclination of one and a half inches to one foot. About one fourth of a miner's inch of water is used on the concentrator, and the concentrations are sold to chlorination works at Angels. The mill is driven by a forty-foot overshot wheel requiring about seventy-seven miner's inches of water,* measured with a four-inch pressure above the top of a four-inch slot. All of the improvements on the property have been made in the last year.

Cost of milling per ton: Water, 83 cents; labor, 69 cents; shoes and dies, 15 cents; incidentals (screens, quicksilver, interest, and insurance), 8 cents; total milling cost, $1 75; transportation cost, 20 cents; mining cost, $2; total, $3 95. These expenses can be very much lessened by bringing in water under a greater head, using the Pelton wheel, and working a larger quantity of rock with increased works.

Altitude (aneroid reading)	1,200 feet.
Length of ore shoot	350 feet.
Length of ore shaft on incline	80 feet.
Depth reached by ore shaft vertically	58 feet.
Vertical depth reached in mine	130 feet.
Character of hanging-wall	Diorite (greenstone).
Character of foot-wall	Talcose slate.
Kind of powder used	Safety Nitro and Hercules, No. 2.
Quantity of powder used	200 pounds.
Cost of mining	$2 per ton.
Cost per foot of tunnel	Special agreement was made whereby the third party received his interest for running the tunnel.
Number of feet timbered	Tunnel, 40 feet; shaft, 40 feet.
Kind of timber	Sawed and round.
Cost of timber	Round, 18 cents per running foot; sawed, $20 per thousand feet.
Cost of transport of ore	20 cents per ton.
Character of ore	Free milling, with large percentage of sulphurets.
Number of stamps	10
Weight of stamps	650 pounds.
Drop of stamps	4 to 6½ inches.
Drops	80 to 90 per minute.
Duty of stamp	1¼ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Nos. 0 and 1 tinned iron, corresponding to Nos. 6 and 9 slot-punched.
Water used in battery	3 miner's inches.
Dimension of apron	4 by 13 feet.
Width of sluice	Apron and sluice are one.
Kind of feeder	Hendy Challenge.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	5
Value of sulphurets per ton	Variable; low grade near surface.

* The battery takes three inches, concentrator one fourth; eighty inches are used for all purposes.

Cost of milling	$1 75 per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	3
Number of men in mine	6
Number of men employed on outside work	3
Total number employed	12
Average wages in mine	$2 50 per day.
Average wages in mill	$2 75 per day.
Average wages paid outside work (two men at $2; blacksmith, $3)	$2 33 per day.
Quantity of water used in milling	3 inches.
Head of water used for power (height of overshot wheel)	40 feet.
Fall of water used for power	80 inches.
Cost of water for milling and for power	$10 per day.

THE SHEEP RANCH MINE

Was located about sixteen years ago, and is situated in the Washington District.

The course of the vein is 15 degrees north of west; the dip easterly, thirty-two feet in one hundred; and the average width of the vein about two feet. The claim is one thousand six hundred by two hundred feet, with an ore shoot one thousand two hundred feet in its greatest length. There are two incline shafts on the mine; the main one, one thousand feet deep, measured on the incline; on the perpendicular, about nine hundred and fifty feet. The hanging-wall is a gray slate, the foot-wall black slate. The mine yields a little over one hundred thousand gallons of water daily, which is extracted by a common plunger pump, eight-inch cylinder, six-inch column, six-foot stroke. Two Burleigh compressors are used and four Ingersoll and National drilling machines. Hercules powder, No. 2, is the kind employed in blasting. The cost of mining and transportation is $3 per ton; the mill being conveniently situated near the mine, the ore delivery to the mill, as far as expense is concerned, is nominal. The cost of running levels is about $5 per foot, and shaft sinking, on the average, $30. It usually takes three months to sink one hundred feet.

The formation passed through was vein matter from the surface to nine hundred feet in depth; at this point, the vein straightening, the shaft was continued into the hanging-wall. There are ten levels in the mine, one at every one hundred feet in depth, from nine hundred to one thousand two hundred feet in length. The one thousand-foot level was run during the past year, and a portion of the nine hundred. Hewed yellow pine timbers, ten by twelve inches, are used, and cost for hewing, 10 cents, and hauling, 2 cents per running foot, the mine being about three miles from the timber, to which the company has built a suitable road. The character of the ore is essentially free milling, the percentage of sulphurets being less than one half of one per cent, assaying $30 per ton; therefore they are not considered of enough value to pay for handling. The ore is milled by the free gold process. The mill is run by steam power, the engine having a fourteen-inch cylinder and thirty-inch stroke. A ten by fifteen-inch Blake crusher, and thirty stamps of eight hundred pounds each, dropping from six to eight inches, eighty-five times per minute, are employed to do crushing and pulverizing, and amalgamation is practiced inside of the battery and on outside plates and sluices. The shoes and dies are of iron, and cost 5 cents per pound at the mill, and a set lasts five weeks on an average. As the mill usually crushes sixty-five tons in twenty-four hours, two thousand two hundred and seventy-five tons of ore wear out seven thousand two hundred pounds of iron—three and sixteen one hundredths pounds per ton, equal to $15\frac{8}{10}$ cents, with iron at 5 cents per pound and rock of this degree of hardness.

About ten inches of water are usually used in the battery. The screens are No. 9 angle slot, and are eight inches by forty-eight inches inside the frame, which is slightly inclined. The apron is four by ten feet; the sluice sixteen inches wide, and one hundred feet long to each battery. Front and back plates are used inside of the batteries, each eight inches by forty-eight inches in diameter and one quarter inch thick. The outside plates are silvered, and have an inclination of one and seven eighths inches to one foot.

The mill is equipped with Hendy feeders, and about 80 per cent of the gold recovered is saved in the battery, and 20 per cent on the outside plates. The number of men in the mine is forty, and seven in the mill, with seven engaged on outside work, or fifty-four men in all in the employ of the company. The average wages paid in the mine are $2 50, in the mill $3 16; engineers are paid $3, and blacksmiths $3 25 to $3. From twelve to fourteen cords of yellow pine wood are used daily, depending on whether it is dry or wet, costing $4 per cord. Of this amount the mill uses four cords, and the mine from eight to ten; one half of this is consumed in running the pump, and the other half for hoisting works and compressor. The wood used by this company is piled under immense sheds, to protect it from rain, as it has been ascertained that one fifth more wood is required for steam purposes when wet. Water costs $75 per month. The information in detail in regard to the plant was most cheerfully given by the Superintendent, Mr. Clary.

The cost of milling per ton: Wood, 25 cents; labor, 39 cents; shoes and dies, 16 cents; quicksilver and screens, 3 cents; water, 4 cents; incidentals, 13 cents; total, $1.

Altitude (aneroid reading)	2,250 feet.
Length of ore shoot	900 to 1,200 feet.
Length of ore shaft on incline	1,000 feet.
Depth of ore shaft vertically	950 feet.
Vertical depth reached in mine	1,048 feet; 50 feet sump.
Quantity of water raised in twenty-four hours	103,000 gallons.
Character of hanging-wall	Gray slate.
Character of foot-wall	Black slate, variable, sometimes changing into quartzite.
Kind of powder used	Hercules, No. 2.
Cost of mining	$3 per ton.
Cost of tunnel	$5 per foot.
Cost of shaft	$30 per foot.
Number of feet timbered	All.
Kind of timber	Yellow pine.
Cost of timber	12 cents per running foot.
Length of road built	Three miles.
Cost of transport of ore	Included in cost of mining.
Character of ore	Free milling.
Character of works	Steam stamp mill.
Number of stamps	30
Weight of stamps	800 pounds each.
Drop of stamps	6 to 8 inches.
Drops	85 per minute.
Duty of stamp	$2\frac{1}{8}$ to $2\frac{1}{4}$ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Angle slot, No. 9.
Water used in battery	About 10 inches.
Dimensions of apron	4 by 10 feet.
Width of sluice	16 inches.
Length of sluice	100 feet.
Kind of feeder	Hendy Challenge.
Percentage of gold saved in battery	80
Percentage of gold saved on plates	20
Percentage of sulphurets	$\frac{1}{2}$
Value of sulphurets	$30 per ton.
Cost of milling	$1 per ton.
Number of men in mill	7
Number of men in mine	40
Total number employed	54

Average wages in mine	$2 50 per day.
Average wages in mill	$3 16 per day.
Average wages paid outside work	Engineer, $3 per day; blacksmith, $3 25 to $3 per day; teamster, $2 per day
Wood used	12 to 14 cords per day, according to whether it is dry or wet
Cost of wood	$4 per cord
Quantity of water used in milling	10 inches
Cost of water for milling	$75 per month

ESMERALDA MINE.

This mine, located in 1885, is situated in the Indian Creek Mining District. It is four miles northwest of Murphys. The course of the vein is a little north of west and south of east. The dip is northerly, at an angle of about 68 degrees. The average width is three to four feet.

The claim is one thousand five hundred by six hundred feet in dimensions. There are three shoots already explored, and there are two more on the surface, the length of which are not determined. No. 1 is one hundred and twenty feet long; No. 2, one hundred feet; No. 3, from one hundred and fifty to two hundred feet.

The mine is worked by an incline shaft two hundred and fifty feet deep, corresponding to a vertical depth of two hundred and thirty feet. The hanging and foot-walls are of slate. The water is taken out with water barrels, at the rate of thirteen thousand gallons daily. The work in the mine is done with three-quarter-inch single hand drills, and about two hundred and fifty pounds of Safety Nitro powder are consumed monthly. The cost of mining and milling is about $5 per ton. The cost of running levels varies with the ground; from $2 to $5 per foot, and from one foot to four feet are usually made daily. Eight dollars per foot was the contract price for the labor in sinking the shaft. It was sunk at about the rate of one hundred feet in six weeks, and followed the vein matter, and is timbered with hewed yellow pine timber throughout, which costs 2½ cents per running foot, up to fifteen inches diameter. The mine is admirably situated for timber, with which it is surrounded. The company constructed two thousand three hundred feet of road, at a cost of $270, and over this road the ore is hauled from the mine to the mill in a cart, at a cost of 45 cents per ton. The ore is free milling, with some sulphurets, and closely resembles the general character of the rock of the mother lode in Amador County.

The ore is crushed in a Dodge rock breaker, pulverized in a stamp battery, and amalgamated on copper plates inside the battery, and on outside plates and sluices; and is then passed over a Frue concentrator, but as there is but one Frue to ten stamps, and great insufficiency of water, and the machine running but little of the time, practically speaking, no sulphurets are caught, excepting a slight quantity in the sluice, although the percentage of sulphurets and value are up to a good standard. The mill, which is run by steam, contains ten stamps, weighing six hundred and fifty pounds each, dropped four and one half to seven inches, according to the rock, and eighty-five to ninety times per minute, crushing on the average one and one half tons per stamp. The shoes and dies are of iron, and cost 4½ cents per pound, delivered, 1½ cents being allowed for old iron returned. A set of shoes and dies will crush six hundred tons of ore. Three and one third pounds of iron, net, are consumed in crushing one ton of ore. That makes the expense of iron for shoes and dies 15 cents per ton of ore crushed. The quantity of water used in the battery is estimated at two inches. The screens are angle slot, No. 8, eight by forty-four inches, measured inside of the frame, which is inclined. The plates outside of the bat-

tery are forty-four inches by twelve feet; those inside are three and one half inches by forty-eight. The plates are silvered, and have an inclination of two inches to one foot. The mill is provided with two Hendy Challenge feeders. Seventy-five per cent of the free gold recovered is in the battery, and 25 per cent on the outside plates. The small amount of concentration saved, and it is very small in proportion to the percentage contained in the rock, is caught in sluices, and on a Frue vanner when sufficient water can be obtained to run it. The average rock contains 2 per cent of iron pyrites, assaying $100 per ton. They are treated by the Plattner process, at the chlorination works at Angels, where 90 per cent of the assay value in gold is paid, and $20 per ton charged for treatment. Thirteen men are employed in the mine (including foremen), three in the mill, and two on outside work, making a total of eighteen men. Miners receive $2 50 per day, men in the mill $2 to $2 50, and outside employés $2. Three and one half cords of wood are consumed per day for all purposes—about two and one half cords at the mill and the balance at the hoisting works. Pine wood, costing $4 per cord, is the kind in use. One dollar per day is paid for water.

A forty-eight-inch boiler, sixteen feet long, supplies steam for the twelve by twenty-four-inch engine which drives the machinery at the mill. A single reel friction-gear hoist at the mine is driven by an engine with six-inch cylinder and ten-inch stroke.

The developments consist of a shaft two hundred and fifty feet deep, with three levels, at ninety, one hundred and fifty, and two hundred and thirty-five feet, respectively, from the surface. It is in contemplation to bring in water from the Union Canal Company's ditch, and run the mill and hoisting works by water power, under a pressure of three hundred to four hundred feet, and add ten stamps more to the present mill.

All of the developments on this property have been made in the past twenty months.

Milling cost per ton: Shoes and dies, 15 cents; labor, 50 cents; wood, 67 cents; water, 7 cents; screens, 1 cent; quicksilver, 2 cents; incidentals, 8 cents; total, $1 50; transportation, 45 cents; mining, $3 05; total expense, $5.

Length of ore shoot, in the aggregate	370 to 400 feet.
Length of ore shaft on incline	250 feet.
Vertical depth reached in mine	230 feet.
Quantity of water raised in twenty-four hours	13,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Safety Nitro, No. 2.
Quantity of powder used	250 pounds per month.
Cost of mining	$3 05 per ton.
Cost of tunnel, labor	$2 to $5 per foot.
Cost of shaft, labor	$8 per foot.
Number of feet timbered	Entire shaft.
Kind of timber	Yellow pine.
Cost of timber	2¼ cents per running foot.
Length of road built	2,300 feet.
Cost of transport of ore	45 cents.
Character of ore	Free milling, with sulphurets.
Character of works	Free milling, steam stamp mill.
Number of stamps	10
Weight of stamps	650 pounds.
Drop of stamps	4½ to 7 inches.
Drops	85 to 90 per minute.
Duty of stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	No. 8 angle slot.
Water used in battery	2 miner's inches
Dimensions of apron and width of sluice (apron and sluice together)	44 inches by 12 feet.
Kind of feeder	Hendy Challenge.

Kind of concentrators	Frue vanner.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	2
Value of sulphurets	$100 per ton.
Cost of milling	$1 50 per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	3
Number of men in mine (including foremen)	13
Total number employed	18
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$2 per day.
Wood used	3¼ cords per day.
Cost of wood	$4 per cord.
Quantity of water used in milling	2 miner's inches.
Cost of water for milling	$1 per day.

ILEX GOLD MINING COMPANY (LIMITED).

This company's property is situated in Rich Gulch Flat, about six miles east of Mokelumne Hill. The course of the vein is north, 81 degrees east, and the dip is southeasterly, at an angle of 85 degrees. The average width is four feet. The dimensions of the claims may be seen by referring to the accompanying plan.

The longest ore shoot is two hundred and forty feet. There are several shorter ones on the mine. The mine is opened by tunnels and shaft. The tunnels are: Tiger, one thousand feet in length; east extension, three hundred and fifty feet in length; Anglo-Saxon, one hundred and eighty feet in length. The vertical depth from the surface reached in the tunnel is two hundred feet. The shaft is both vertical and incline. Its depth on the incline is two hundred and seventy-five feet. The vertical depth reached is two hundred and seventy feet. The formation of walls is mica schist on the hanging. A diorite (greenstone) dike runs with the vein, and on the foot-wall mica schist on the main vein. The walls of the north vein are granite. The mine yields about one hundred and forty-four thousand gallons of water in twenty-four hours. One eight-inch jackhead pump and two five-inch jackhead pumps are used. The National compressor and Sargent drill are used. One thousand two hundred pounds of Safety Nitro powder are consumed monthly. Four thousand and twenty-three pounds of drill steel are in use. No estimate is given of the monthly consumption of steel, or the cost of mining, per ton of ore, as operations have but recently been commenced on a large scale.

The tunnel cost $2 75 per foot, "upwards," the average being $9 76. The number of feet run per day is about one. The shaft cost $23 69 per foot. One to two feet were sunk per day. The shafts are all timbered, and the tunnel when it required it. Pine timber, costing $12 to $19 per thousand, is hauled seven miles. The company built no ditches, but repaired the old ones, and constructed and laid six thousand five hundred feet of fifteen-inch pipe and two thousand feet of eight to eleven-inch pipe, connecting them with mill and mine.

The ore is brought to the mill from the mine by gravity. Tramways are constructed from the mine to the mill. The ore is quartz, containing free gold, iron and copper sulphurets, zinc blende, etc. The methods of treatment are amalgamating plates for free gold, Frue vanners for saving the sulphurets, and chlorination for recovering the gold in the concentrates.

The hoisting works of this company, at the time of erection, were the highest in the county, the gallows frame being in the neighborhood of one

ILEX GOLD MINES,

RICH GULCH, CALAVERAS Co., CALIFORNIA

1886.

SECTION ON THE VEIN.

SCALES.

Horizontal 180 Ft.–1 Inch, — Vertical 60 Ft.–1 Inch.

hundred feet in height. All ore not falling through a grizzly, passes to a large crusher, eleven by fifteen inches, situated at the hoisting works, and is broken before going to the mill, which has bins above three eight by ten crushers, which still further reduce the size of the rock. The mill is complete in every particular. It is run by Pelton wheels, or steam power, independent of each other.

Number of stamps, forty; weight of each, eight hundred and fifty pounds; drop, seven inches; drops per minute, ninety-five. Chrome steel is used for shoes and dies; the cost is 9 cents per pound. As the mill has just commenced running, no record can be given as to the wear and tear of shoes and dies. Brass wire screens, No. 30 mesh, are used, standing vertically. Eight Loftus feeders, and sixteen Frue vanners are used. The percentage of sulphurets is from ½ to 2 per cent. The value per ton is $205—in gold, $156; in silver, $49.

The number of men in the mine, thirty-six; mill under construction at the time of visit; the number of men employed on outside work, forty-four; the total number of men employed, eighty. The average wages paid are $2 50 per day.

When steam is used, three cords of wood are necessary. The cost of pine and oak wood per cord is $4. There are three six-foot Donnelly wheels; three Pelton wheels, six feet, five feet, and three feet, respectively; and one Knight eight-foot wheel. The mill is run by a Harris Corliss engine, fourteen-inch cylinder, thirty-six-inch stroke. The compressor is twenty-inch by twenty-inch by twenty-four-inch.

At the hoisting works, steam power, when used, is communicated by one Hendy engine, six-inch by ten-inch, and one Hinckley, Spiers & Hayes engine, twelve-inch by fourteen-inch. The crusher is run by a Globe engine, ten by twenty-two inches. The hoisting engine is ten by twelve inches. Water costs from 14 to 20 cents per inch.

For developments see the plan attached. Tunnels, drifts, and crosscuts, two thousand one hundred and ninety feet; winzes and uprises, one hundred and forty-four feet; shafts, four hundred and seventy-seven feet; stations and plats, ten thousand nine hundred and fourteen cubic feet.

The proposed improvements are sinking two shafts and opening two levels on the Tiger mine, and other exploration.

All of the improvements made by this company are the finest probably in the State of California, and no expense has been spared to construct everything in the best possible manner.

Altitude (Courtis)	1,800 to 2,400 feet.
Length of ore shoot	240 feet.
Length of ore shaft on incline	275 feet.
Vertical depth reached in mine	400 feet.
Vertical depth of water shaft	210 feet.
Quantity of water raised in twenty-four hours	144,000 gallons.
Character of hanging-wall	Mica schist.
Character of foot-wall	Mica schist.
Kind of powder used	Safety Nitro.
Quantity of powder used	1,200 pounds monthly.
Cost of tunnel	$9 76 per foot.
Cost of shaft	$23 69 per foot.
Number of feet timbered	All.
Kind of timber	Pine.
Cost of timber	$12 to $19 per thousand feet.
Length of ditch built	27 miles put in repair.
Number of stamps	40
Weight of stamps	850 pounds each.
Drop of stamps	7 inches.
Drops	95 per minute.
Kind of shoes and dies	Chrome steel.
Size and character of screens	No. 30 mesh brass wire.
Kind of feeder	Loftus.

Kind of concentrators ....Frue vanners.
Character of ore...Free milling and concentrating.
Percentage of sulphurets.. ½ to 2
Value of sulphurets... $205 per ton.
Number of men in mine.. 36
Total number employed.. 80
Average wages in mine .... $2 50 per day.
Average wages paid outside work .... $2 per day.
Wood used .... 3 cords per day.
Cost of wood... $4 per cord.
Head of water used for power...
................500 to 700 feet—for mill, 640 feet; compressor, 700 feet; for hoist, 500 feet.
Cost of water for power...Estimate for all wheels, 200 miner's inches, at 20 cents per inch.

THE LOCKWOOD MINE.

This property is situated in the West Point Mining District, about three miles northeast of West Point. The course of the vein is northwest and southeast; the dip is westerly at the surface, but at a very small angle from the perpendicular and at the lowest workings is vertical. The average width of ore throughout is about three feet. The claim is one thousand five hundred feet by six hundred feet in width, and on it are two shoots: the main, or north one, one hundred and sixty-nine feet in length, with a width of three and a half feet at one end, and five feet at the other; and the south shoot explored for one hundred feet; the full extent of neither shoot having as yet been determined. The mine is opened by three shafts, practically vertical; the north one, three hundred and fifty feet deep, the middle one, one hundred and sixty-five, and the south one, one hundred and thirty-five feet in depth. The hanging and foot-walls are granite. The vein is cut by a dike of greenstone, from two to six feet thick, nearly at right angles to it, and pitching slightly to the south. This dike has made no difference apparently in the character of the ore, which is the same on each side. The water, which is in no great quantity, is removed by a Hooker pump with three and one half-inch column. Work is performed in the mine with single and double hand drills, and in the levels from one to two feet are run per day, and in the shaft, which is a double compartment, twelve and one half by four and one half feet in the clear, about four and one half feet were sunk per week, at a cost for labor by contract of from $25 to $30 per foot. Vein matter, quartz, etc., were passed through in sinking, and owing to the hard nature of the walls, not very much timbering has been required; in fact, the ore can be removed to the shaft without incurring injury or danger. Round timbers, squared on one side, were employed when needed, costing 5 cents per running foot for all sizes from six inches to twenty-four inches in diameter at the smaller end. For procuring timber the mine is admirably situated, being almost in the heart of a dense forest. The company has built some seven miles of ditch, and one and one half miles of road connecting the mine and mill. At present the ore is hauled in wagons, at a cost of 50 cents per ton. The ore, which is hard and contains a large percentage of sulphurets, is treated by two different processes. After it has been crushed in a Blake crusher, about seven and one half tons of ore are pulverized and amalgamated daily in a wet crushing battery, and amalgamated on electroplated aprons and sluices, and concentrated on Frue vanners. From seven to eight tons are taken from the rock breaker, and pulverized dry in a Dodge mill, and treated by pan amalgamation in three different kinds of pans.

The result of experiments, according to the statement of the Superintendent, is that "stamps pay the best in the end," and the pulverizer is to be removed and replaced with five additional stamps. The mill is arranged

for both steam and water power. The boiler is forty-two inches by sixteen feet, and the engine has a twelve-inch cylinder and twenty-four-inch stroke. Water is applied to a four and a half-foot Knight's wheel, under a pressure of one hundred and ten feet. The Blake crusher has an eight by twelve-inch opening. The milling machinery consists of a Challenge feeder, one five-stamp battery of eight hundred and fifty-pound stamps, one Dodge pulverizer, two Wheeler, one Boss, and one Fulton pan, two settlers, eight feet in diameter, and two Frue vanners. The stamps drop from five to six inches, at the rate of eighty-five times per minute, crushing one and one half tons per stamp in twenty-four hours. At present steel shoes and dies are being tried as an experiment, and cost 9½ cents delivered at the mill. No regular record has been kept as to wear of shoes and dies, but so far, it is stated, steel seems to be an improvement on iron in the matter of cost. The total capacity of the mill, stamps, and pulverizer is about fifteen tons in twenty-four hours. In the battery, about one miner's inch of water is used. The screens are slot punched, one fourth inch straight No. 10, eight inches by forty-eight inches inside of the frame, which is slightly inclined. The height of discharge is seven inches, when the dies are new. The mortar is nine inches deep, from the bottom to the lip, and twelve inches in width. The diameter of the shoe is eight and one fourth inches. The aprons are four feet seven inches wide and five feet long, and the sluice is thirty inches wide and twelve feet long. The plate inside of the battery is six inches wide and forty-eight inches long; silvered plates are used inside, as well as on the aprons and sluices—the aprons having an inclination of one and three fourths inches to the foot, and the sluices one and one half inches. In the pans some cyanide of potassium, bluestone, common salt, and concentrated lye are used, but there is no record kept of the quantity consumed, which however does not make a large item of cost.

Of the ore worked in the stamp mill, the recovery of free gold in the battery amounts to 75 per cent, and on the outside plates 25 per cent. The pans are run independently on the ore pulverized dry in the Dodge Mill, and by this method about 90 per cent of the value of the ore is saved, and the same amount by wet crushing, amalgamating, and use of Frue vanners, the tailings by either process assaying about $2 26 per ton. The ore contains about 6 per cent of sulphurets, consisting of iron and copper pyrites and arsenical, antimonial lead and zinc sulphurets, and is a general mixture, including some magnetic oxide of iron; their value is about $50 per ton. They were formerly treated at the company's works, in a muffle furnace fifty feet long, containing eight muffles eight feet long, which had a capacity for about four tons per day, and consumed six cords of wood, but since the erection of custom chlorination works near West Point the sulphurets are treated there, at a charge of $20 per ton, with an allowance of 90 per cent of the gold assay. There are in the mine twenty-four miners; there are eight men in the mill; besides these there are engaged one foreman, three blacksmiths, two brakemen, two carmen, one carpenter, one machinist, two teamsters, two ditchmen, and two laborers, or forty-eight men in all. In the mine $2 50 to $3 are paid daily, the same in the mill; laborers receive $40 per month and board; carmen, $2 50 per day; brakemen, $2 75; carpenters, blacksmiths, and machinists, $3 to $4. For steam purposes at the hoisting works, one and one half to two cords of yellow pine and oak wood, costing $2 50 per cord, are consumed. Two cords are used per week in drying the ore for the pulverizer.

At the hoisting works the machinery consists of two engines, one eight by twenty-four inches and the other ten by sixteen, furnishing about forty-horse power; they are connected with a steel boiler fifty-four inches in

diameter and sixteen feet long. Steam is not usually employed, only in case of failure of water for power. The company owns its own ditches, and hence has free water. By laying two thousand five hundred feet of pipe it can get four hundred feet of pressure at the mine. The developments, other than shafts, consist of levels. At one hundred and thirty feet from the surface, at the north shaft, there is a level running north twenty feet for the pump and tank, and running south two hundred and fifty feet, connecting with the middle shaft, sunk for the purpose of ventilation and escape of men in case of emergency. At one hundred and eighty feet from the surface the level runs north forty-five feet and southerly one hundred and nine feet. There is one level in the south shaft, eighty feet from the surface, running southerly one hundred and five feet. Nearly all developments below the one hundred and thirty-foot level have been made during the last year. It is proposed to erect ten stamps more, of seven hundred and fifty pounds each; to add four Frue vanners to the mill; to bring water to the mine, and put in a Burleigh compressor, and Ingersoll drills. The Lockwood is the principal mine belonging to this company, or, rather, the one most developed. Five other mines are under the same ownership, developed by shafts from forty-five to one hundred and thirty-five feet in depth, and said to contain pay ore of good grade.

Altitude (aneroid reading)	3,000 feet.
Length of ore shoot (two), aggregating	269 feet.
Length of ore shaft on incline	250 feet.
Depth of ore shaft vertically	250 feet.
Vertical depth reached in mine	250 feet.
Vertical depth of water shaft	250 feet.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Kind of powder used	Hercules, No. 2.
Cost of shaft (labor)	$25 to $30 per foot.
Number of feet timbered	All.
Kind of timber	Round yellow pine.
Cost of timber	5 cents per running foot.
Length of road built	1½ miles.
Length of ditch built	7 miles.
Cost of transportation of ore	50 cents per ton.
Character of ore	Free milling and concentrating.
Character of works	Stamp mill, pulverizer, pans, and concentrating.
Duty of Dodge pulverizer	7½ tons in twenty-four hours.
Number of stamps	5
Weight of stamps	850 pounds each.
Drop of stamps	5 to 6 inches.
Drops	85 per minute.
Duty of stamps	1½ tons in twenty-four hours.
Kind of shoes and dies	Experimenting with steel.
Size and character of screens	Straight slot, No. 10.
Water used in battery	1 miner's inch.
Dimensions of apron	4 feet 7 inches by 5 feet.
Width of sluice	30 inches.
Length of sluice	12 feet.
Kind of feeder	Challenge.
Kind of pans	1 Boss, 2 Wheeler, 1 Fulton.
Number of pans	4
Number of settlers	2
Kind of concentrators	Frue.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	6
Value of sulphurets	$50 per ton.
Cost of milling	$1 75 per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	8
Number of men in mine	30
Number engaged on outside work	10
Total number employed	48

Average wages in mine	\$2 50 to \$3 per day.
Average wages in mill	\$2 50 to \$3 per day.
Wood used	1¼ to 2 cords per day.
Cost of wood	\$2 50 per cord.
Quantity of water used in milling	1 inch.
Head of water used for power	110 feet.
Quantity of water used for power	250 inches.
Cost of water for milling and power	Free.

BLAZING STAR AND WATER LILY MINES.

These are parallel veins, situated about one and one half miles northeast of West Point, and under the ownership of the same company. Their general course is northwest and southeast, and their width varies from a few inches to three feet. The dimensions of each claim are one thousand feet in length and six hundred feet in width. The country rock is granite, and the shafts are sunk on the veins at an angle of about 35 degrees. The developments on the Blazing Star consist of an incline shaft about two hundred feet in depth, with one level at one hundred and fifty feet from the surface, running south about seventy-five feet. The incline on the Water Lily is about two hundred and thirty feet deep; at one hundred and thirty feet below the surface a level is driven northerly and southerly seventy-five feet; at two hundred and ten feet in depth a level is driven southerly twenty feet, and northerly one hundred feet. The improvements on the property consist of steam hoisting works, and a three-stamp mill, with nine hundred-pound stamps, and a Frue concentrator. The ore is amalgamated in the battery and on outside plates, and the sulphurets (amounting to 5 or 6 per cent of the ore) are recovered on the Frue vanner, and sold to the chlorination works, about a mile distant, where 90 per cent of the assay value is paid, less a charge of \$20 per ton for treatment. The property is well situated, as regards timber and wood, for which the same prices prevail as at the Russell Reduction and Mining Company's works. Some little work is being done on several other mines in the West Point District, as for instance on the Scorpion and old Woodhouse properties.

THE ANGELS MINING COMPANY.

The Angels Mine, the property of this company, consists of two veins—the Crystal or "west" and the Angels or "east" vein. The mine was one of the earliest quartz locations in the Angels District, if not in the county. It is situated midway between Angels and Altaville, about one half mile west of north from the former. The course of the vein is north 16 degrees west, and the dip 74 degrees east of north; at the surface having a slightly perceptible angle from the perpendicular, but near the bottom of the shaft acquiring an inclination of 52 degrees. The dimensions of the claim are one thousand three hundred and fifty-four feet in length by six hundred feet in width, and within these bounds there are four shoots, one of them two hundred feet in length, and the others aggregating about three hundred feet, with widths varying from eight to twenty feet. The mine is opened by three shafts: No. 1, an incline, two hundred and ten feet deep, five feet by ten in the clear, timbered with twelve-inch round timbers, and having two compartments; No. 2, also an incline, two hundred feet deep, with two compartments, timbered with round and square timbers, and five feet by eight in the clear; No. 3, a three-compartment vertical shaft, one hundred and ninety-one feet deep, five feet by twelve, inside measurement, timbered with twelve-inch square yellow pine, with exception of center braces, which are eight by twelve-inch. The hanging-wall is diorite (green-

stone) and the foot-wall is talcose slate. About one miner's inch of water is yielded by the mine daily in summer, and two inches in winter, or, for the year, an average of about twenty-six thousand gallons daily. An eight-inch Wilcox steam pump is employed to remove the water, and has a two hundred-foot lift, a ten-foot suction, and three-inch column.

A Burleigh compressor (capable of running five drilling machines) and the Ingersoll Eclipse drill are used, and from nine hundred to one thousand pounds of Safety Nitro powder, No. 2, are consumed monthly. The cost of mining and milling is not determined, on account of the irregularity with which the work has thus far been carried on, but a fair estimate of probable cost would be that of the neighboring mines, the Utica and Stickles. The cost of running levels on the vein has been from $4 to $5 per foot, and of drifts across the vein about $6. With one drilling machine three feet per ten-hour shift were made in the shaft; in crosscutting one hundred and eleven feet of progress were made with power drills* in thirty-nine shifts of ten hours each. The formation passed through in sinking is diorite. The sets of timber are placed five feet apart from center to center, and the material when sawed costs $20 per one thousand feet. Round barked timber is delivered for 12½ cents per running foot, with diameter from eight to eighteen inches at the smaller end. The ore is free milling, and contains about 1½ per cent of sulphurets. After being hoisted from the mine in a self-dumping skip, it passes to the hopper of a Blake improved breaker, nine by sixteen inches in size, making two hundred revolutions per minute, and run by an eight by twelve-inch engine. The crushed ore, loaded from the shoot into the car, thence going to the self-feeders, is subsequently pulverized in three J. B. Low mills, making about thirty-six revolutions per minute, and each containing two twenty-inch steel or chilled iron balls weighing eleven hundred pounds each. The discharge is on both sides through round-punched tinned screens, Nos. 8 and 9, and the capacity of the three mills is said to be fifty tons per day. The ore is amalgamated in the mill, and also on outside silvered plates, which are four by eight feet on the apron, and sixteen inches wide by six feet in the sluices, with an inclination of one and one half inches to one foot. The sulphurets are recovered on six Frue vanners and riffle sluices, and sold at the reduction works at Angels, where a charge of $20 per ton is made for treatment, and an allowance of 90 per cent of the gold contents. The Low mills or pulverizers are driven by a four-foot Donnelly wheel, and the concentrators by a twenty-inch Donnelly. Forty-three inches of water are required to drive the machinery, and seven inches are used in milling and concentrating, at the rate of 8 cents per miner's inch.† The sulphurets amount to nearly 2 per cent of the weight of the ore; they are principally iron pyrites, and have a value of from $50 to $150 per ton. Experiments in the use of quicksilver in these pulverizers seem to prove the loss quite insignificant; in one case the loss of quicksilver in working about eight hundred and fifty tons of ore was stated by the mill Superintendent to have been but one and one half pounds, or twenty-eight one thousandths of an ounce per ton of ore worked, or but little over $\frac{1}{10}$ of a cent to the ton. About two and one half cords of wood are used for the compressor, and one and one half cords for the hoisting works, steam pump, and rock breaker. At the hoisting works a double engine, ten by twelve-inch, is used, and two steel boilers, sixteen feet long and fifty-four inches in diameter, with one stack, arranged to run single or double. The engines are

*Power drills and drilling machines are used as synonymous terms in this connection.
†The measurement here employed is four inches above the top of a four-inch slot.

connected by pinion and spur gearing with the reel shaft, on which are two four-foot drums, with brass bushing, and running loose. Other improvements consist of a fine blacksmith shop, changing room for the miners, four hundred feet of tramway from the mine to the mill, with a grade of one half inch in sixteen feet, and gauge of eighteen inches, equipped with twelve-pound "T" rails. The developments on the south, or No. 1, shaft, consist of three levels—one at one hundred feet in depth, running one hundred and twenty-five feet south; one at one hundred and thirty feet deep, running north and south sixty-six feet; one at two hundred feet, running north six hundred and fifty feet, and south one hundred and twenty-five feet. Shafts Nos. 1 and 2 are about three hundred feet apart, and connected on the lower level, and also with the new shaft, by a crosscut of one hundred and fifty-one feet, and drift, by which an excellent system of ventilation is secured.

Cost of milling per ton: Labor, 18 cents; water, 8 cents; quicksilver, $\frac{1}{10}$ cent; incidentals (wear and tear, screens, taxes, insurance, etc.), 15 cents; total, $41\frac{1}{10}$ cents.

Altitude (aneroid reading)	1,500 feet.
Length of ore shoot (aggregate)	500 feet.
Length of ore shaft on incline	210 feet.
Vertical depth reached in mine	191 feet.
Quantity of water raised in twenty-four hours	26,000 gallons.
Character of hanging-wall	Diorite.
Character of foot-wall	Talcose slate.
Kind of powder used	Safety Nitro, No. 2.
Quantity of powder used	900 to 1,000 pounds monthly.
Cost of mining	Not determined; estimate, $1 50 to $2 per ton.
Cost of tunnel	$4 to $5 per foot.
Number of feet timbered	All.
Kind of timber	Square and round yellow pine.
Cost of timber	Square, $20 per thousand; round, 12½ cents per running foot.
Cost of lagging	$80 per thousand.
Cost of transport of ore	4 cents.
Character of ore	Free milling.
Character of works	Water power, pulverizing, and concentrating plant.
Duty of three mills	50 tons in twenty-four hours.
Size and character of screens	Tinned iron, round punched, No. 9.
Water used in three mills	7 inches.
Dimensions of apron	4 by 8 feet.
Width of sluice	16 inches.
Length of sluice	6 feet.
Kind of feeder	Low.
Kind of concentrators	Frue.
Percentage gold saved in mills	25
Percentage gold saved on plates	75
Percentage sulphurets	1½ to 2
Value of sulphurets	$100 per ton.
Cost of milling (based on working 50 tons)	$41\frac{1}{10}$ cents per ton.
Cost of working sulphurets	$20 per ton.
Percentage value extracted from sulphurets	90
Number of men in mill (including foreman)	3
Number of men in mine (including foreman)	21
Number employed outside	4
Total number employed	28
Average wages in mine	$2 50 to $3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 to $3 per day.
Wood used	4 cords per day.
Cost of wood	$4 per cord.
Quantity of water used in milling	7 inches.
Head of water used for power	146 feet.
Quantity of water used for power	43 inches.
Cost of water for milling	7 inches at 8 cents, 56 cents.
Cost of water for power	43 inches at 8 cents, $3 44.

QUAKER GOLD MINE.

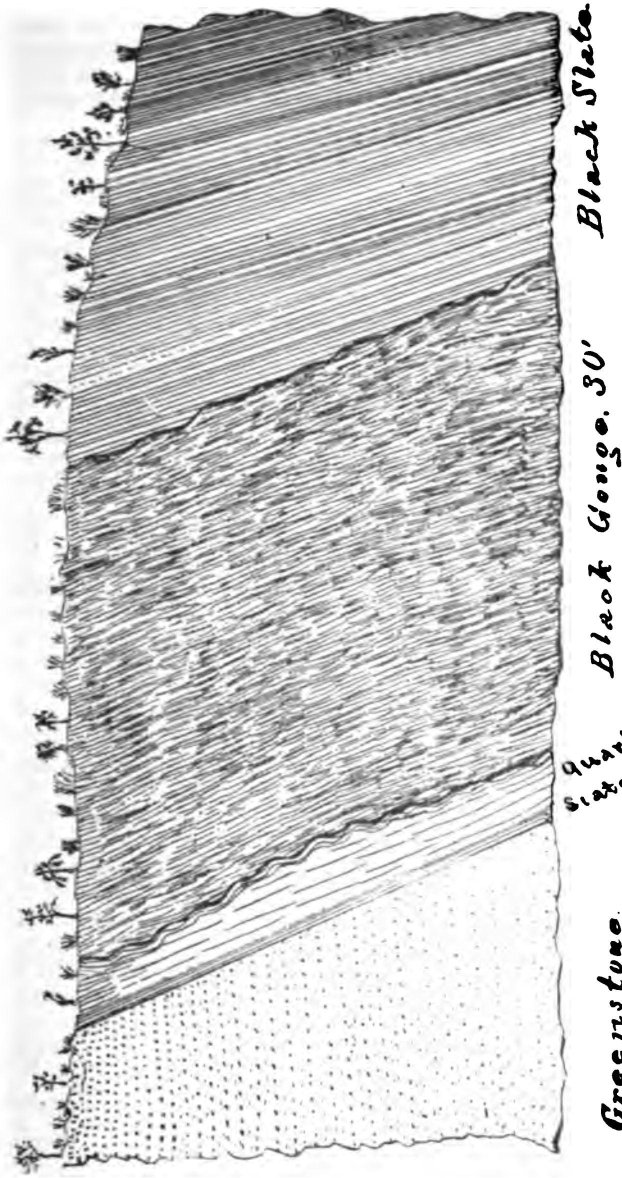
This mine was located about twenty years ago, and is situated four miles from Mokelumne Hill, and its direction is a little west of south from that town. The course of the vein is north, 30 degrees west. The dip is north, 60 degrees east, at an angle of about 68 degrees from the horizon, and the average width is three feet. The ore closely resembles the rock of the mother lode in Amador County; so do the diorite (greenstone), black slate, and gouge. The arrangement of slate, gouge, quartz, and greenstone is sufficiently peculiar to deserve notice.

The claim is of the usual dimensions, one thousand five hundred by six hundred feet, and the ore shoot, as far as determined by present exploration, is about one hundred feet in length, and pitches northerly. The mine is opened by a drain tunnel six hundred and forty feet long, and a perpendicular shaft, which connect at one hundred and two feet below the surface.

The hanging-wall of this mine is black slate, but between it and the ore there is about thirty feet or more of soft black gouge. Immediately on the foot of the ore vein from six inches to five feet of black slate occur, and under the slate lies diorite (greenstone), as represented in the accompanying cross-section. Operations having just begun on this property, mining and other costs are more or less in the nature of estimates; but it is fair to presume that the cost will be very near those on the mother lode in Amador County, where the rock and conditions are quite similar.

As in other mines of this nature, a No. 2 nitro-glycerine powder is generally used. The shaft is sunk through slate and gouge, and so is the tunnel. All of the shaft is timbered, and three hundred feet of the tunnel. Sawed timber is used in the shaft, and round timber in the tunnel, the sawed costing $23 per thousand, and the round 8 cents per running foot, from six inches to fourteen inches in diameter. The timber is hauled about twenty miles. The ore is taken from the mine to the works over a short trestle, in dump cars, the man landing the car from the cage acting as carman.

The ore is free milling and contains a small fraction of one per cent in iron pyrites. The ore is crushed in a Blake rock breaker, eight by ten-inch, and fed automatically into a six-foot Huntington centrifugal mill, making sixty revolutions per minute. It is amalgamated in the mill and then on outside silvered plates; these have a grade of two inches to one foot, as all the pulp from this mill has to pass over a single set of aprons. The works at the mine consist of a single gear friction hoist, with four and one half-foot drum, and three quarter-inch steel wire cable. The hoisting works are driven by a Knight four and one-half foot wheel, under one hundred and eighty feet of pressure, requiring twenty miner's inches of water. The gallows frame is substantial, and the two-compartment shaft, eight feet by four feet nine inches in the clear, has guides for cage and is completely equipped for prospecting work. The elevated tramway, connecting the mine and mill building, is an excellent one, as is the mill building itself. Besides the crusher and Huntington mill, the building covers a grade made for Frue vanners, should the percentage of sulphurets on further exploration of the mine render them necessary. The mill is run by water power applied to a Knight wheel, under two hundred and twenty-five-foot pressure. The water costs 20 cents per miner's inch, which is reckoned on a pressure of four inches above a slot three inches wide in a two-inch plank. The probable quantity of water required for the mill is four inches, and the screens used Nos. 7 and 8 slot punched. The apron and sluice are in one,



VERTICAL CROSS SECTIONS, QUAKER GOLD MINE. (Scale, 12½ feet to 1 inch.)

four feet wide and twelve feet long, covered with electroplate. The mill is equipped with a Hendy feeder. When the property was visited the mill was under construction and work was being pursued irregularly. Five men were at work underground and seven men engaged in construction work, under contract. The wages of the miners are $2 50 per day. The company, in order to secure water power, constructed seven hundred and twenty-five feet of pipe to make connection with the Mokelumne ditch; of this, four hundred feet are thirteen inches in diameter, made of No. 16 iron, and three hundred and twenty-five feet are eleven inches, of No. 14 iron.

Altitude (Lanyon, Superintendent, authority)	950 feet.
Length of ore shoot	100 feet.
Depth of ore shaft vertically	108 feet.
Vertical depth reached in mine	108 feet.
Quantity of water raised in twenty-four hours	None.
Character of hanging-wall	Black slate.
Character of foot-wall	Diorite (greenstone) with slate between it and ore.
Kind of powder used	Giant, No. 2.
Number of feet timbered	Tunnel, 300; shaft, 102.
Kind of timber	Yellow pine, sawed and round.
Cost of timber	Sawed, $23 per thousand feet; round, 8 cents per running foot.
Cost of transport of ore	Nominal.
Character of ore	Free milling.
Character of works	Huntington centrifugal mill, six-foot.
Size and character of screens	Nos. 7 and 8, slot punched.
Dimensions of apron	4 by 12 feet.
Kind of feeder	Hendy Challenge.
Percentage of sulphurets	Less than one half.
Value of sulphurets per ton	Not determined.
Number of men in mine	5
Total number employed	12
Average wages paid in mine	$2 50 per day.
Average wages paid outside work	$2 25 per day.
Quantity of water used in milling	4 inches.
Head of water used for power	180 feet at hoisting works, 235 feet at mill.
Cost of water for milling and power	20 cents per inch.

BUENA VISTA MINE.

This mine is situated in the Telegraph Mining District, and is about four miles easterly from the town of Milton. The hanging and foot-wall are diorite (greenstone). The course of the vein, which is about five feet in width, is northwest and southeast, with a southerly dip of about 30 degrees from the horizon. The dimensions of the claim are one thousand five hundred feet by three hundred. The claim is opened by a tunnel, which taps the vein seventy-five feet from the surface, and an uprise from this point carried on the vein. The improvements consist of a Kendall mill, run by steam power.

Length of ore shoot	400 feet.
Length of ore shaft on incline	75 feet.
Vertical depth reached in mine	65 feet.
Character of hanging-wall	Diorite.
Character of foot-wall	Diorite.
Kind of powder used	Giant, No. 2.
Cost of mining	$1 50 per ton.
Cost of tunnel	$5 per foot.
Cost of shaft	$7 per foot.
Kind of timber	Pine.
Cost of timber	$24 per thousand.
Length of ditch built	1½ miles.
Character of ore	Free milling.
Character of works	Kendall mill.
Kind of shoes and dies	Steel.
Size and character of screens	Wire, 40-mesh.
Dimensions of apron	3 by 6 feet.

Percentage of gold saved in battery	50
Percentage of gold saved on plates	50
Percentage of sulphurets	1
Value of sulphurets	$200 per ton.
Cost of milling	$1 50 per ton.
Number of men in mill	2
Number of men in mine	3
Total number employed	7
Average wages in mine	$2 50 per day.
Averages wages in mill	$2 50 per day.
Average wages paid outside work	$2 50 per day.
Quantity of water used in milling	2 miner's inches.

THE UNION GOLD MINE.

This property is situated about three miles south of San Andreas, and is equipped with steam hoisting works at the shaft, which is about four hundred feet deep. Sinking, drifting, and crosscutting is in progress. A fine mill has been erected by this company, and consists of an improved Blake crusher, thirty stamps, and twelve Frue concentrators, and is arranged for both steam and water power, independent of each other. The water for the mill is applied on a five-foot Pelton wheel, while the concentrators and rock breaker are run by two three-foot Pelton wheels. The mill is furnished with an electric light plant. The company is at present engaged in prospecting and developing the mine.

THE PLYMOUTH ROCK.

This claim is situated in the Brushville Mining District, about seven miles north of Milton. It was located first about twenty-five years ago. A ten-stamp mill, seven hundred and fifty-pound stamps, was erected on the mine about twenty-one years since, and the frame of the building is now standing. The mine ceased operations, after a time, on account of the unsatisfactory returns of the mill. The course of the lead is northwest and southeast, and appears to dip to the southwest at an angle of 60 degrees. There is a United States patent on three hundred by one thousand two hundred feet, and also on a millsite, three hundred feet east and three hundred feet south, which have been added, by separate location, to make a full claim. Neither the width of ore nor length of shoot can be determined from the amount of present development. Nor is there any well defined hanging or foot-wall. There are eight miles of ditch, in repair, carrying two hundred and fifty inches of water, connected with the property. The principal amount of ore worked from the mine was taken from a large surface chamber showing great width. The developments consist of a tunnel three hundred feet long, and three little shafts, from eight to fifteen feet in depth, and several surface pits. The greatest vertical depth reached is about one hundred and fifty feet. The ore is peculiar, being a kind of gold-bearing talcose vein matter, without association with quartz, and in depth heavily sulphureted. Good prospects are obtained in fine free gold on examination of surface rock.

Between Milton and Copperopolis, four miles west of the latter town, there is a little three and a half-foot Huntington mill running with a No. 3 Dodge breaker for crushing. The average capacity of the works, on the kind of rock usually worked, which is soft, is about ten tons per day, the ore being amalgamated in the mill and on electroplates. In connection with this mill, which is run by steam power, and part of the time works custom ore of the neighborhood, are three locations, called the Erie, Mammoth, and Salt Spring. On the Mammoth is a sixty-foot incline; on the

Salt Spring a thirty-foot incline; on the Erie a tunnel forty feet in length. The veins have a course northwest and southeast, with dip and width undetermined, with diorite on the hanging-wall side and slate on the foot. Wm. Hendricks and others have half a dozen or more quartz locations about four miles northwest of Copperopolis, having a northwest and southeast course, the principal one, the Goodenough, one thousand five hundred by six hundred feet. On this location is an open cut one hundred and ten feet long, fifteen feet from the top of the cropping. A tunnel cuts the vein ninety feet below the open cut, and runs thirty feet on the vein. At this point the ore lies rather flat, and is about ten feet thick. Ten feet lower than the mouth of the tunnel a shaft sunk fifty-five feet encounters the ledge and a drift follows on the vein thirty-five feet. The width here is about ten feet. The ore prospects in free gold. The Pine Log claim in this neighborhood, on the surface has an ore shoot about seven hundred feet long and from one to three feet thick. The dimensions of the location are six hundred by two thousand feet. Several hundred tons of the ore have been worked in a mill in the last two or three years. The course of the vein is like the others in the vicinity. The deepest shaft is one hundred and thirty feet.

The Bulger claim is six hundred by one thousand five hundred feet; has greenstone hanging and slate foot-wall; is opened up for two hundred feet in cuts and little shafts; has a width from one to two feet. An incline on the ledge is thirty-five feet deep. The ore all prospects more or less in free gold. The owner has done all the work alone on the claim and has made a living from it with a hand mortar for the last two years.

Four miles northeast of Milton, there occurs some manganese ore of good grade. No work has been done on the claim, excepting the amount necessary to hold the location, and no intelligent estimate can therefore be made as to probable yield.

MOKELUMNE HILL.

In the vicinity of Mokelumne Hill there are a number of stamp mills working on cemented gravel, some of them having been quietly and profitably running for years. The batteries are usually double discharging, and amalgamation is performed in the mortars and sluices. Among these properties may be mentioned the Calaveras Blue Gravel, with ten-stamp mill, the Duryea with five stamps, the ten-stamp mill of the late Anthony Chabot, and the Green Mountain Gravel Mill, with eight stamps of six hundred and fifty pounds each. This mill is run by water power under a pressure of two hundred and seventy-five feet. The stamps have a drop of eleven inches and a speed of ninety drops per minute, discharging from seventy to seventy-five carloads of gravel per day through one quarter inch mesh screens.

THE CALAVERAS HYDRAULIC MINING AND WATER COMPANY.

This company operates extensive beds of gravel, about six and one half miles north of Milton. There are about four hundred acres in the claim. Three brush, stone, and earth dams have been constructed, which, for all practical purposes, completely impound the debris, and the water after leaving the last dam is nearly as clear as when it goes into the pipe above the gravel. About twenty-five men are employed, and one thousand five hundred miner's inches of water (Amador County measurement) are used daily through two giants with six-inch nozzles. Where most of the work

is being carried on at present the gravel is somewhat cemented, and requires blasting, but disintegrates with sufficient readiness not to require stamps, and is worked in sluices. There are about ten or twelve feet of blue gravel next to the bedrock. This property has been worked, under different names, for about sixteen years, with exception of one year while in litigation with the City of Stockton on the question of debris. As it was conclusively proven that the system of dams employed practically prevented injury from tailings, the mining company finally won its case, and a hint is given to hydraulic companies similarly situated.

ANGELS CHLORINATION WORKS.

These works have a capacity of three tons per day. The furnace is eighty feet in length, thirteen feet in width, and six feet high, outside measurement; the stack is two feet by two feet in the clear, and about forty feet high. The walls of the furnace are one foot in thickness; the bridge wall is thirteen inches, and from the top to the grate bars is fourteen inches, and the drop from the bridge wall to the hearth is twelve inches; the ash pit is eighteen by twenty-two inches. There are nine doors on each side of the furnace. One ton of dried sulphurets is introduced into the furnace every eight hours and moved forward successively to that portion of the furnace called the middle oven, into which twenty pounds of salt are distributed and thoroughly mixed with the charge; the sulphurets are gradually brought toward the hottest part of the furnace called the third oven, and after remaining there about eight hours are drawn and spread on the cooling floor. There are three chlorination tanks, nine feet in diameter at the bottom and three and one half feet deep. About four tons of the roasted charge, properly moistened, are screened on to the filter prepared in the bottom of the tank. Three gas generators are used for one tank, and each requires thirty-two pounds of manganese, thirty-six pounds of salt, and about six gallons of sulphuric acid, 66 degrees in specific gravity. "Gassing" is continued for six to eight hours, and the charge allowed to stand in gas two days. Water is then turned on and allowed to remain in the tank about one half hour; it is then run into the base tub, into which one gallon of sulphuric acid is added; from the base tub the solution is siphoned into two precipitating tanks, and protosulphate of iron is added until no more precipitate is formed. The solution is allowed to stand two or three days in order to completely settle; the clear solution is then siphoned off into a sluice box, which conveys it to outside tubs for further treatment if necessary. One and one quarter cords of pine wood, costing $5 per cord, are consumed in roasting three tons of sulphurets. Three men are employed on the furnace at $2 50 per day, and one chlorinator at $3 50, and one floorman at $2 50, an assayer, and a superintendent.

THE MALTMAN REDUCTION AND CHLORINATION WORKS.

These works are situated about three quarters of a mile due east of West Point, and have a capacity for treating three tons of sulphurets in twenty-four hours. The steam plant for driving the milling machinery consists of a tubular boiler thirty-six inches in diameter and twelve feet long; an engine, ten-inch cylinder and sixteen-inch stroke, running at one hundred. The rock is pulverized by a No. 3 Dodge crusher, and a Tustin dry pulverizer, making twenty-five revolutions per minute, which has a capacity of discharging two and one half tons of the hardest rock in the district through a No. 40 screen in twenty-four hours, and requires a cord of pine

wood in performance of this work. The roasting furnace has three hearths, and is built of common brick outside and in, and has an iron stack, which lasts about one year. The sulphurets treated usually contain iron, copper, lead, antimony, arsenic, and zinc. The percentage of value saved in working is stated to be 95 per cent of the gold contents; 90 per cent of the assay value of the sulphurets, in gold, is allowed, and a charge of $20 per ton is made for treatment. Three tons of sulphurets require about two cords of wood, which costs, delivered, $2 50 per cord.

THE UNION COPPER MINE AND THE KEYSTONE

Adjoining it are at present under one ownership. The lode on which these mines are situated, and on which, at time of discovery, they were most conspicuous in outcropping, was located on the fourth of July, 1861, by W. K. Reed, and from him named the Reed Lode. It was then in the Upper Mining District, and the first house was erected at the mine September 5, 1861, where subsequently the town of Copperopolis was built. The general course of this lode is north 30 degrees west. In early days many claims were taken up on this lode, following the course for more than fifteen miles, but the Union and Keystone were most productive on exploration, as they were the most promising at the surface. The dip is northeasterly, with an average angle of about 71 degrees from horizontal. It is very difficult to arrive at the average width; it varies in its average from twelve to forty feet. At two hundred feet the lode is twenty-one feet in width; at the two hundred and fifty-foot level, thirty-one feet. The Union Copper Mine comprises the Union claim, one thousand nine hundred and fifty by three hundred feet, and the Keystone claim, one thousand nine hundred and fifty by three hundred feet. The length of the shoot is not known, as the northerly limit of the shoot has never been reached. There may be more than one shoot within the limits of the claims, but that has not yet been determined.

This property is opened by ten shafts. The combined depth of six shafts is two thousand feet; of the remaining four, one thousand feet. No. 1—Vertical and incline combined. Nos. 2, 3, and 4 (Keystone shaft)—Vertical. Some of the others are vertical and some inclined. Two of the shafts are five hundred feet in depth, each vertical; one shaft, three hundred and fifty feet, vertical; others from eighty to three hundred feet. The vertical depth reached is five hundred feet to the bottom of the sump.

The Formation of Walls.

The walls are variable in places along the trend of the cupriferous deposits, and differ in depth; thus we have in places argillaceous slate and chlorite, sometimes passing into hornblendic slate, and sometimes serpentine occurs in the immediate proximity of the lode. The country rock on either side appears to have the same changing character. The lamination of the inclosing walls is parallel to the ore bodies. It is not absolutely certain that they have ever found the true hanging-wall. Both the hanging and foot-wall are permeated with strata of copper ore parallel to the main ore channel. These ore bodies, though not "true fissure" veins, are very persistent in strike and dip, length and depth.

The mine has been yielding seventy thousand gallons of water this season daily, but the mine is not thoroughly drained, the water having been so recently removed from the mine. The true amount of water to be handled daily it is estimated will be about fifty-five thousand gallons for the year

through. No pump is used, but self-filling, self-emptying buckets, one holding one hundred and forty gallons, and the other two hundred gallons, are in use.

Two thirds of the work in the mine is done with seven eighths inch single hand drills, and one third is done with inch steel and double hand hammers. Hercules and Safety Nitro powder is used, and, at present, three hundred and fifty pounds are consumed per month. The quantity of steel consumed is estimated at forty pounds monthly. As the shafts and levels were run before the present owners acquired the property, it was not easy to obtain accurate information as to costs per foot, and, indeed, when the work was done, in the days of double-hand drilling, and black powder, and higher wages, the cost of all work would be so much greater than at present, that the information would chiefly be useful as comparative, furnishing no standard wherewith to judge future work. At least two thousand feet of shafts and tunnels are timbered. Yellow pine, sawed and round, is used. Sawed timber costs $20 per thousand. Round timbers average $2 each in cost, taking the whole tree. Split pine lagging costs $60 per thousand for five-foot lengths, and $70 per thousand for six-foot lengths. It is from one mile to fifteen miles to timber.

Character of the Ore.

On the discovery of the mine in 1861, considerable oxidized ore was found on the surface, some of it red oxide and some pyrites of copper oxidized to a black "smut," called by some "oxysulphuret of copper." Some fine specimens were found—crystalline native copper and masses of malachite. The oxidized ores and carbonate of copper, native copper, etc., gave out at twenty-five or thirty feet below the surface, and were replaced by copper pyrites, more or less mixed with iron pyrites, correspondingly reducing the percentage of copper from the standard required for pure chalcopyrite. These mechanical mixtures of iron and copper pyrites are so intimately blended often, as to affect but slightly the color of the ores. These are the ores which are now being mined, shipped to New York, and sold on assay of carload samples, in fifty-ton lots. There are no works here for either smelting or leaching, and the improvements consist chiefly in hoisting works, company's office, assay office, laboratory, blacksmith shop, etc.

Hoisting Works, Etc.

There are four buildings, each inclosing a separate gallows frame, boilers and engines, and hoisting machinery. Three of the gallows frames are twenty-four feet high, and one is twenty feet. One engine has sixteen-inch cylinder and three-foot stroke, for hoisting; two engines have twelve-inch cylinders and two-foot stroke, for hoisting; one engine with eight-inch cylinder is used for hoisting; one engine with eight-inch cylinder is designed for pumping, but it is not in use, as it is found more desirable to remove the water by buckets. Four flue boilers are used, about twenty-four feet long. No water power is used. One shaft has two compartments, and another four. The latter shaft is eight by eight feet in the clear, having two compartments for hoisting, one for ladder-way, and one designed for a pump-way, should a pump be used. At one shaft, spur and pinion gear is used, reels three feet three inches in diameter; at the other shaft friction gear is employed, two five-foot single reels, and one-inch diameter Hallidie steel wire cable.

Length of ore shoot	Not known.
Depth of ore shaft vertically	500 feet.
Vertical depth reached in the mine	500 feet.
Vertical depth reached in the water shaft	500 feet.
Quantity of water raised while removing water from the shaft	200,000 gallons daily.
Quantity of water now yielded by the mine	70,000 gallons daily.
Quantity of water yielded by the mine, averaged daily	55,000 gallons.
Character of hanging-wall and foot-wall varying	Chlorite, argillaceous slate, hornblendic slate, serpentine.
Kind of powder used	Safety Nitro.
Quantity of powder used	350 pounds monthly.
Number of feet timbered	2,000
Kind of timber	Round and square pine.
Cost of timber	$20 per thousand, sawed; round, $2 per log; lagging, $60 to $70 per thousand.
Character of ore	Mechanical mixture of iron and copper sulphurets.
Number of men in the mine	15
Number of men outside	25
Total number of men employed	40
Average wages in the mine	$2 50 per day.
Average wages paid outside workmen	$1 75 per day.
Wood used, when both engines run	6 cords per day.
Cost of wood	$3 50 per cord.

Miscellaneous.

The mine was resuscitated in 1887, after having been idle many years. The Union Mine proper was shut down for nineteen years. The machinery was put in proper order, and at one shaft was entirely renewed. The company commenced to take out the water, June, 1887. In May, 1888, the water had been lowered to three hundred and seventy-five feet from the surface and was being lowered at the rate of ten feet per day. Ore is being raised from the mine regularly and shipped to the East. Three shafts are connected on two, three, and four levels. The shafts are three hundred feet apart. The nearest levels to each other are thirty feet; the greatest distance apart of two levels is ninety-seven feet. The present owners are Boston men. H. D. Ranlett is General Manager and J. A. Ferson Superintendent, who has kindly rendered every assistance in gathering data in regard to the property. The group of copper mines at Campo Seco, and the Newton Mine in Amador, elsewhere described, appear to be nearly, if not directly, in line of the general course of the Union and the other locations of the Copperopolis group, and the inclosing walls do not differ from each other any more, comparing one mine with the other, than do the rocks in the same walls of the same mines differ from each other. In the same distance, the wall rocks of the mother lode differ still more. The ores of the Union Mine are oxidized and leached with much less facility than those occurring at the Newton Mine in Amador County, which are said to be peculiarly adapted to ready oxidation and leaching.

THE PENN CHEMICAL WORKS.

The Campo Seco Mine, now called the Penn Chemical Works, was located at a very early day, and from it was extracted and shipped large quantities of copper ore of good grade. It is situated in the Campo Seco Mining District, in Calaveras County, one and one half miles northwesterly from the village of Campo Seco, and about four and one half miles west of north from Valley Springs, the terminus of the San Joaquin and Sierra Nevada Narrow Gauge Railroad. The course of the vein is a little west of north and east of south; the direction of the dip is easterly, but the exact angle has not as yet been accurately determined. The dimensions of the claim are two thousand one hundred and twenty-three and eighty-six one hundredths feet in length, and four hundred feet in width.

The ore shoot, so far as explored, proves to be one hundred and fifty feet in length, though, in one direction, the end has not been reached.

The shaft is four by eight feet in the clear, and was sunk many years ago, following a rich stratum of the vein. It is in part inclined, in part vertical. At its greatest depth, two hundred feet, it stands twenty feet from perpendicular. A winze was sunk, seventy-five feet below the level of the bottom of the shaft, at an angle of 45 degrees, and has ore on all sides. The formation of the walls of this vein is slate. About fifteen thousand gallons of water are daily raised from the mine. The average yield of water is greater monthly from April to July than during the other months of the year. A six-inch copper Cornish jackhead pump is employed to raise the water. The pump cylinder is one eighth inch copper, inserted into position in a cast-iron exterior cylinder, and there secured by pouring molten lead in the space made by the difference in diameters of the copper and iron cylinders. The four-inch column is of seamless copper, one eighth inch in thickness. The different lengths are joined together by copper flanges, with rubber gaskets between. The employment of copper for pump cylinder and column was necessitated by the rapid oxidation of iron in this water, so highly impregnated with metallic salts. Hercules powder, Nos. 1 and 2, are employed in blasting.* The cost of mining may be stated at a little less than $1 per ton, a large amount having been taken out, by contract, at 88 cents per ton. No record of cost of shaft or underground levels or drifts is conveniently obtainable, that work having long since been done by previous owners.

Vein matter, generally, is the formation passed through in shaft or level. Timbering is necessary in all the workings of this mine. This company, by judicious foresight, aided by natural situation, obtain their timbers at unusually reasonable rates. Their works, being situated about eight hundred feet distant from the Mokelumne river, are located conveniently as respects a boom for logs and wood. The boom is the property of the company, and logs and wood are floated, from twenty to thirty miles, down the Mokelumne, almost to their works. Logs sixteen, eighteen, and twenty feet in length, with diameter at smaller end from ten to twenty inches, are delivered at $2 25 each. Cordwood, which would otherwise cost $5 per cord, is delivered at $3. The mine and leaching works are in close proximity. By aid of cars, the ore is distributed on the immense roasting piles, and conveyed, at a mere nominal cost, to a large mechanical roaster.

The ore is a sulphuret of copper and iron, carrying a trace of zinc sulphuret, but no arsenic or antimony. The average ore contains about 8 per cent of copper, by assay, Swedish process.

Clay and quartz are of frequent occurrence as gangue. The ore is first roasted in heaps, varying in quantity from one hundred to one thousand tons, the size of the piles being a matter of convenience. About one cord of ordinary pine wood is consumed in roasting one hundred tons of ore. One man is employed to pile the ore, as dumped from the cars, and his duty is to arrange in pile form fifty to seventy-five tons of ore per day. Wood is used only at the bottom of the piles, being conveniently arranged for purposes of draught. After the ore has roasted in heaps, for about four months, it is removed in cars, passed through a large rock breaker, in combination with a certain percentage of bisulphate of soda, automatically elevated and fed into a rotary horizontal furnace, twenty-eight feet in length and five feet in diameter, inside measurement, revolving very slowly. The furnace is an octagonal cylinder in shape, and, at each one eighth revolu-

*Cost of powder to five thousand five hundred tons ore last extracted was $285, and cost of candles, fuse, caps, steel, shovels, and picks, for same amount of ore, $136.

tion, the pulverized ore, resting on beds successively horizontal, is turned over, and fresh surfaces are presented to the action of heat and air. The throat of the furnace, wherein the ore enters, is smaller than the discharge end. The fire enters the larger or discharging end, opposite the end to which the ore is supplied. Bisulphate of soda, a waste product from the acid works, is procured for little over the price of freight from San Francisco. The part of the process after leaving the rock breaker is entirely automatic until the re-roasted ore is consigned to the leaching vats. By this method it is claimed that fully 90 per cent of the copper contained in the ore can be extracted. The ore passes from the roaster into a large brick chamber, thence is removed to cooling floors, and subsequently, to leaching tanks.

The works are supplied with three leaching tanks, sixteen feet square, capable of holding twenty tons each, and they have together a leaching capacity of fifty tons per day. The last trace of soluble copper salt is in solution in twelve hours after water is introduced in the tanks. A permanent gravel filter six inches deep is prepared in the bottom of the tanks. This is covered with broad slats, placed near to each other, that the solid residue, after leaching, can be easily removed by shoveling. These filters remain for years, and are in perfect order for subsequent leaching operations. After the solution has been drawn off, the solid residuum, conveyed to convenient situations, is allowed finally to undergo a natural decomposition, and, in course of years, yields, by constant spraying with water, its last atom of copper value. The precipitation is principally performed at these extensive works in large barrels, holding about four thousand gallons each, by aid of sheet iron as a precipitant. Three hours only are required to effect entire precipitation. It is said that, by this method, one pound of iron will precipitate nearly one pound of copper, while by the old process, where stationary tanks or sluices are employed, two or three pounds of iron are required for depositing one pound of copper from solution. The barrels are provided with safety valves, for the escape of hydrogen gas generated in course of precipitation. It has been observed that one cord of pine wood is consumed in roasting one hundred tons of ore in heaps. This roasted ore subsequently requires one eighth of a cord of wood to one ton of ore, while being further treated in the rotary furnace. Or, in all, thirteen and one half cords of wood is nearly the amount for one hundred tons of ore. Fourteen men are employed under ground, two on the outside, and four Chinamen. In the mine, men receive $2 50 per day, as compensation; on the outside, $2. Chinamen are employed at $1 37½. Wood, either pine or oak, costs $3 per cord, delivered.

The hoisting works are capable of reaching a depth of five hundred feet. The power employed is water, applied to a five and one half-foot Pelton wheel, under a pressure of one hundred and ninety feet. The reduction works, under similar pressure, are also supplied with a five and one half-foot Pelton wheel. Thirty-five miner's inches of water are required to run the hoisting works, pump, and reduction works (reckoned with a four-inch pressure over the top of a slot four inches wide, made through an inch board). Fourteen cents per inch is charged every twenty-four hours. The hoisting works require one half of the water. The balance is consumed for power at the reduction works and in leaching. A portion of the ore is treated in the old way—that is, by passing the solution through long tanks two feet wide and one foot deep, in which has been placed scrap iron.

A double stationary trestle, or suspended double car track hung on trusses, which are eleven feet above the base of the ore heaps, runs under sheds for over eleven hundred feet. Over these car tracks the cars dis-

tribute ore to the various heaps under cover, needed for protection against the winter rains.

The developments on the mine consist of a shaft two hundred feet deep, with a winze seventy-five feet deeper, and three levels, one at eighty feet, one at one hundred and forty feet, and one at two hundred feet.

During the present year the water has been removed from the mine, the different levels have been opened, the shaft and two hundred-foot level have been retimbered, and the mine supplied with a new copper pump and column; hoisting works have been erected and one thousand one hundred feet of sheds constructed*, thirty feet in width, and a double line of railroad, with steel "T" rails, averaging fifteen pounds per yard, from the mine to all the sheds, and large leaching tanks placed in the works. It is proposed to have electric lights in the hoisting and leaching works, and in the sheds over the roasting heaps.

The altitude is about 600 feet.
The length of the ore shoot, 150 feet.
The depth of ore shaft on incline, 200 feet; the depth of ore shaft, vertically, nearly 200 feet; the vertical depth reached in the mine, 252 feet.
The water raised in twenty-four hours, 15,000 gallons.
The hanging-wall and foot-wall are slate.
Hercules powder, Nos. 1 and 2, is employed.
The cost of mining is under $1 per ton.
All of the work in the mine is timbered. The cost of Oregon pine lumber is $26 to $28 per thousand; mountain pine or spruce, $22 per thousand; timbers, ten to twenty inches in diameter, sixteen, eighteen, and twenty feet long, $2 25.
Freight to San Francisco is $4 75 per ton, in carload lots.
The character of the works is leaching. About two hundred pounds of bisulphate of soda† are used to one ton of ore. One cord of wood is consumed to one hundred tons of ore, when roasting in heaps. One eighth of a cord to each ton of roasted ore is required in the subsequent mechanical roasting.
Sixteen men are employed in the mine and outside works, including brakemen and blacksmiths. The average wages paid in the mine are $2 50; the average wages paid outside are $2 25. Cost of wood per cord is $3.
Total amount of water used is thirty-five inches. The pressure is one hundred and ninety feet. The cost of water is 14 cents per miner's inch. About equal quantities of water are used in hoisting works and leaching works.
It is estimated the cost of production of fine copper, shipping, selling, and commission, by this process, will not exceed 7 cents per pound.

The Penn Chemical Works are provided with a fine office, with sleeping rooms above, for the accommodation of officers of the company, a good chemical laboratory, stone powder house, boarding and lodging house for accommodating fifty men, blacksmith shop, carpenter shop, stable, etc.

The leaching works are inclosed in a fine, commodious building, sixty feet wide and one hundred and thirty feet long, with floors on different levels. The two precipitating barrels are twenty-four feet long by six feet in diameter, inside measurement, run upon six trucks, and make three revolutions per hour. The staves of the barrels are of wood, six inches thick. They require about one horse power each. One Chinaman attends the rock breaker, and receives $1 37½ per day. One Chinaman, at same compensation, attends the revolving barrels, and four fill and discharge the leaching vats. It is proposed to produce ingot copper, 98 to 99 per cent fine, from the cement, and suitable furnaces for melting and refining the cement have already been constructed.

This plant, just described, is the only one of the kind on the Pacific Coast. The works are systematically arranged and are very extensive and complete. Everything is constructed with a view to permanent work. The whole being under the management of Mr. C. Berger, Superintendent.

*The ore sheds have a capacity of twelve thousands tons.
†Bisulphate of soda is used according to the percentage of copper contained in the ore.

SAN FRANCISCO COPPER COMPANY.

Adjoining the Penn Chemical Works, on the south, are situated the mines and works of the San Francisco Copper Company. The company has two hoisting works, run by water power, employing two Knight wheels. This mine is on the same lead as the Campo Seco Mine, and in the same formation. They roast their ore in heaps and leach on the piles—conducting the copper sulphate to precipitating sluices. They employ from twenty to thirty men. The mine is opened by two shafts from three to four hundred feet deep each. The same prices prevail, for labor, as at the Penn Chemical Works.

THE HECKLA MINE.

North of the Penn Chemical Works is situated the Heckla Mine, on the same lead as the property of the Penn Chemical Works. A shaft is sunk on this mine five hundred feet in depth. It was formerly known as the "Copper Hill" mine. The old company, so local history, apparently not contradicted, says, shipped between four thousand and five thousand tons of ore containing from 15 to 20 per cent copper. A patent for this property is being applied for, and work will be resumed at a very early period.

IRON ORE—MONARCH MINE.

Not more than a mile and a half north of the railroad depot at Valley Springs, there is situated an extensive deposit of limonite. The average assays of the croppings therefrom have yielded between 55 and 60 per cent metallic iron. The ore is said to be very pure, analyses by different chemists detecting no phosphorus. The outcropping appears for several thousand feet, in a north and south line, and in places is over one hundred and fifty feet wide from east to west. It appears on the surface in vein form, with strike north and south, and dip east. Two crosscuts, twenty-five feet in length, and seven feet deep, and a few shallow holes dug on this claim, with exception of a tunnel ninety feet in length, to crosscut the ore body at one hundred and fifty feet deep, constitute all present developments. The tunnel has not reached the deposit. An extension of this location contains a kind of shale, impregnated with iron peroxide, to such an extent as to render it suitable for a pigment, for which it has often been employed. It has a fine bright yellow color. The deposit has sufficient extent, considering its accessibility, to entitle it to notice.

Limestone occurs within three miles of this iron deposit, in an extensive belt, from which supplies of lime have been continuously obtained for neighboring towns for thirty years or more.

PROSPECT NEAR VALLEY SPRINGS.

One and one half miles west of Valley Springs a gold-bearing vein occurs, on which a shaft has been sunk one hundred feet. From this shaft a crosscut has been run for twenty-five feet in ore. It is said to be of paying grade, though none has been worked in large quantities. The walls are of black slate, resembling the black slate found on the mother lode in Amador County. A peculiarity of this mine is to be inclosed in walls of this kind so far west of the supposed line of the mother lode.

SANDSTONE.

An excellent sandstone for building purposes occurs close to the railroad at Valley Springs. The stone is said to be easily worked and very durable. A house constructed of this material over twenty-five years ago stands near the railroad, the stone employed in its construction showing no signs of injurious weathering after this long exposure.

COLUSA COUNTY.

The name of this county is of Indian origin, though its significance is not well established. Colusa is bounded on the north by Tehama County; on the east by Butte and Sutter; on the south by Yolo, and on the west by Mendocino and Lake Counties, the Sacramento River on the east and the summit of the Coast Range on the west constituting the boundary lines on these two sides respectively.

The western one third of Colusa is occupied by the easterly slope of the Coast Range, these mountains reaching here an altitude of several thousand feet. The remainder, composed of rich agricultural lands, is nearly level. The tule lands lying along Sycamore and other sloughs making into the Sacramento River cover about thirty thousand acres.

This county is fairly well watered, the Sacramento River running along its eastern boundary. Stony Creek at the north, and Sycamore Creek at the south, run east and empty into the Sacramento. Bear Creek, with its tributary Sulphur Creek, in the southwestern corner of the county runs south and empties into Cache Creek, which has its sources in this county. The only timber found in Colusa consists of a scattered growth of white oak on the valley lands, with a few cottonwoods along the streams, the mountains being covered with a sparse growth of white oak and scrub pine.

Colusa, though a great wheat growing county, contains a variety of mineral products, the more important of which consist of gold, copper, cinnabar, sulphur, coal, petroleum, bitumen, natural gas, clay, and limestone. There are also several mineral springs in the county, some of them noted for their medicinal properties.

The principal gold quartz mines in the county are the Clyde and the Manzanita, located on Sulphur Creek; the latter the only gold mine in the county now producing or being actively worked. Along Bear Creek and in the vicinity of these mines, many of the gulches have afforded some placer diggings, but being neither rich nor extensive, the amount of gold obtained from them has not been large.

THE MANZANITA MINE.

This mine is located on Sulphur Creek, twenty-seven miles southwest of Williams, a town on the California and Oregon Railroad. The original claim, located February 21, 1863, is two thousand seven hundred by one thousand feet. More recently the North Star and Mendocino claims, each one thousand five hundred by six hundred feet, have been added to the company's property. The country rock here consists of sedimentary shales and a sandstone with occasional outbursts of eruptive rock. In many places these rocks are coated with a siliceous sinter, evidently deposited from hot siliceous waters, traces of which, in the form of thermal springs, are still plainly visible. This substance not only coats the rocks,

but it has found its way into all their cracks and crevices. It has, as a rule, free gold associated with it and constitutes the auriferous ore of the district. The gold does not appear to permeate the quartz, but is deposited on it in the form of an incrustation. This is the case at least in such parts of the mine as contain much of this sinter. In many places this sinter is associated also with cinnabar and bitumen, which latter is often in such quantity that it causes great loss of gold, imparting a coating to the water that causes the gold to float off with the tailings. This mine is located on a bluff hillside on the northern side of the creek. The old workings here consist of numerous cuts and tunnels, run wherever the rock showed sufficient value to justify its extraction. With all the exploration done, however, no well defined vein has been developed.

As yet no definite limit has been found to the area of ore-bearing ground, but, in working, pay ore has rarely been met with more than seventy-five feet below the surface. Under the present management the mine is being exploited by surface stripping, carried as far as assays show the pay ore to extend.

From the mine the ore is trammed to a ten-stamp mill, where it is crushed through No. 8 screens. The stamps weigh nine hundred and fifty pounds each and make one hundred drops per minute. The pulp passes over blanket sluices for the purpose of concentration. The concentrates are worked in two combination pans, sodium amalgam and bluestone being used with the charges.

Altitude	1,350 feet.
Kind of powder used	Giant, No. 2.
Quantity of powder used	250 pounds per month.
Character of ore	Free gold, with sulphurets.
Number of stamps	10
Weight of stamps	950 pounds.
Drops	100 per minute.
Drop of stamps	6½ to 9 inches.
Duty of stamp	3 tons in twenty-four hours.
Kind of shoes and dies	Chilled cast iron.
Size and character of screens	No. 8, slot punched.
Kind of feeder	Hendy.
Kind of pan	Combination.
Number of pans	2
Kind of concentrator	Blanket sluices.
Length of tunnel	230 feet.
Number of men in mill	4
Number of men in mine	13
Total number employed	17
Average wages paid	$2 75 per day.
Wood used	2½ cords per day.

NATURAL GAS.

On the south side of Sulphur Creek, about three hundred yards back of the original Wilbur Springs, there is a gas well which has been burning for years. The gas here comes to the surface near a small stream which empties into Sulphur Creek. The entire formation at this point is a coarse-grained friable sandstone. The gas issues under a slight pressure, and burns with a flame resembling that of a "Bunsen Burner." This flame rises from eight inches to two feet. No effort has ever been made to utilize this gas.

BITUMEN AND COAL.

About three quarters of a mile south of the gas well, on Sulphur Creek, bitumen, associated with coal, occurs in small bunches in the sandstone. At the Manzanita Mine this mineral is found associated with the ore. In

this vicinity a number of wells were bored in search of petroleum during the years 1864-65. Though sunk to a depth of several hundred feet, they failed in their purpose, notwithstanding the promising oil signs on the surface.

ARAGONITE.

At the head of Sulphur Creek occurs a vein of aragonite, consisting of two seams, each about five inches thick. The color of this mineral is for the most part a deep rich brown. A quantity of the stone in the rough, sent to England, found there a ready market. The property, comprising some forty-eight acres, is owned by the California Onyx Company, of San Francisco.

MERCURY.

Small deposits of cinnabar have been found at various localities along Sulphur Creek. They have not been opened up to any extent, nor would they probably pay for working at the present prices of quicksilver.

SULPHUR.

Several solfatara appear along Sulphur Creek. Some sulphur was shipped from here many years ago, but the business was, after a short trial, abandoned, as not being profitable.

COPPER.

Cupriferous veins have been found at the head of Bear Valley, and in the vicinity of Smithville. As they remain undeveloped, little is known in regard to their value.

CLAYS.

There is, in this county, plenty of clay, impure, but suitable for manufacturing bricks, of which enough are made for home requirements.

MINERAL SPRINGS.

Of the several mineral springs in this county, Wilbur's and Cook's are the best known. The water of the former is highly charged with sulphuretted hydrogen and chlorides, and is used to a considerable extent in rheumatic and cutaneous complaints.

CONTRA COSTA COUNTY.

This county originally, and before Alameda County was formed from its southern half, extended along the east side of the Bay of San Francisco nearly its entire length. The region so covered by it was by the Spanish called "Contra Costa," meaning opposite coast. This county is bounded on the north by the Bay of San Pablo, the Strait of Carquinez, the Bay of Suisun, and the San Joaquin River; on the east by San Joaquin County; on the south and southwest by Alameda County; and on the west by the Bay of San Pablo.

Striking north and south across this county are two ridges of the Coast Range, the Mount Diablo on the east, and the Contra Costa on the west; some of the peaks in these ridges reaching an altitude of nearly four thou-

sand feet. Between them occur several broad and fertile valleys, with others equally fertile but of less extent. Extending west from the Contra Costa hills to the Bay of San Francisco is a wide plateau, sloping gently towards the bay. San Ramon Creek, flowing north across the middle of the county, and Marshio Creek, flowing eastwardly into the San Joaquin, are the only considerable streams in the county, the former being at high tide navigable for some distance by small craft. But while this county contains so few running streams, it possesses over seventy miles of deep waterfront, the most of which can easily be made available for the accommodation of sea-going vessels. This, with her numerous railroads, insures for Contra Costa easy access and cheap transportation.

This county is as nearly timberless as almost any in the State, the only tree growth left, since the cutting away of the groves of redwood that once stood on the crest of the Contra Costa hills, consisting of a sparse growth of oak, with a few stunted pines, and a little madrona on the slopes of Mount Diablo.

MINERAL RESOURCES.

The most extensive and productive coal mines in California occur in this county, being located on the northwesterly slope of Mount Diablo. The output of these mines, formerly quite large, has for several years past been much reduced. Stimulated by the present high prices of the mineral fuels, the extraction of coal from these mines has lately been very much increased. Gold, silver, copper, cinnabar, and petroleum have all been found in small quantities in this county. However, none of these products have as yet been obtained in quantity. Deposits of pottery clay, limestone (suitable for making hydraulic cement), and beds of the ochreous earths also exist here, some of these minerals having in times past been largely utilized, and, with the facilities enjoyed for marketing this class of products, it may be expected that more of them will in time be turned to practical account. There is also much building stone that may be utilized in districts not too far removed from means of transportation. The mining interests of the county are naturally centered in the Mount Diablo coal mines. The output of the Empire Coal and Railroad Company, for the year ending with May, 1888, averaged two thousand to two thousand five hundred tons per month, costing, delivered at the wharf at Antioch, \$2 75 to \$3 per ton, the price obtained being about \$4. This company is about to deepen the incline on the Black Diamond vein, at Stewartsville, which will enable them to increase their output from one thousand to one thousand five hundred tons per month. The Empire Company is also opening the West Hartley vein, about half a mile west of the old Empire Mine, with which it will probably make connection. The company expects to produce over three thousand tons per month from this new working. During the year ending with May, 1888, about one hundred men have been employed on the works of this company. The new undertaking will occasion the employment of nearly three times that number, should remunerative prices for fuel be maintained.

PITTSBURG COAL MINE.

These mines, owned by the Somersville Coal Company, have yielded during the year ending with May, 1888, about four thousand tons of coal per month, at a cost of \$2 75 per ton, delivered at the Pittsburg Landing, where the price for unscreened coal has ranged from \$3 to \$3 50 per ton. These mines are situated about one mile distant, across the mountain from

Stewartsville. A narrow gauge railway, running from Somersville, conveys the coal to the wharf at Pittsburg Landing (Los Medanos), which is the shipping point on the Sacramento River for this company. Mr. Rankin, the manager of the company, states that in consequence of the recent high price of fuel, and the greatly increased demand for Pittsburg coal, two new tunnels are being driven upon the Black Diamond vein, and the old Independent shaft is to be reopened. These new workings will be hardly likely to increase the output of these mines during the present year, being all in the nature of developments; they will, however, increase the produce for next year, to the amount of five thousand tons per month, should current prices warrant a vigorous prosecution of the work. Another coal field is about to be reopened on the west slope of Mount Diablo, on the Galindo tract, in Pacheco Valley, about four miles southeast of Concord, and within two miles of Clayton. The coal measures at this point were opened some years ago, but although a tunnel of about two hundred feet had been driven, work was abandoned in consequence of litigation involving a title to the property. The legal claims have been settled in favor of F. Galindo, and he has granted a lease to an experienced coal miner, who is about to develop the property.

NATURAL GAS.

Inflammable gas has been discovered at various places in Contra Costa County. At Byron Springs, as mentioned in the description of the same, and at Lafayette, where a boring has been made by Benedict, Capel & Co., of Oakland.

POTTERY CLAY.

A stratum of pottery clay occurs in the coal measures of the county, extending for several miles along the general strike of the coal. It differs at various points both in quantity and quality. No analysis of it has been made, but practical working tests have proved it to be suited for the manufacture of terra cotta and stone ware. It was used several years ago for the latter purpose by Isaac Dobree & Bros., at Antioch, where their large old-fashioned kiln now stands. A pottery was subsequently started under the name of the Albion Pottery Company, at Antioch, in 1868, and run successfully until 1886. Eastern parties have lately been negotiating with a view of erecting extensive pottery works at Antioch. An abundance of pottery clay occurs within a few miles of Antioch, and can be hauled to the latter place by teams for about $1 per ton, or by the Empire Narrow Gauge Railroad coal road, for less than half that sum, delivered at the waterfront. The greater part of the clay that has heretofore been used by the Antioch pottery works, came from the Brentwood Coal Mine. This mine belongs to the Clay Street Savings and Loan Society, of San Francisco, but is not now in operation. Mr. Stewart, of Stewartsville, says that this clay, which passes into a clay shale at Stewartsville, is in some places one hundred and fifty feet in thickness; it is, however, interlaced with sandy strata, being more sandy towards the top, and increasing in argillaceous character towards the bottom. Apparently good clay crops out, however, at so many places in the foothills of Mount Diablo, that providing chemical analysis does not reveal a decided superiority, preference lies with the most accessible.

LIMESTONE.

Impure limestones are a marked feature in the geology of Contra Costa County, and have been used for the manufacture of lime. There are, no

doubt, many places in the county where the limestone is of local value for that purpose. In some districts the limestone is of an hydraulic character. Somewhat similar limestones crop out in several other localities in the county, but of course it would require chemical analyses to determine whether it would be suitable for cement.

SHELL MARL.

Shell marl occurs in several places in Contra Costa County. The deposit is variable in thickness and in the size of the shells of which it is composed. In one place it has been cut into for a depth of over twenty feet.

METALS.

The Ryne Quicksilver Mine, which is situated some four miles southeast of Clayton, is still in litigation. This mine was formerly operated by Ryne & Co., and the ore reduced on the premises. During 1875, 1876, and 1877 the mine was run with good success. At one time it is said to have produced eighty-five flasks of quicksilver per month. Cinnabar ore is also said to have been discovered in other localities. Silver claims have been located, and a small amount of work done upon them by Messrs. Donner & Stephens and Mr. Carpenter within a few miles of Clayton. The ore is said to assay $10 to $12 per ton, and the ledge to be three to four feet wide. Copper claims are also said to have been located on Mount Diablo.

BUILDING STONE.

At the present there are but few quarries opened in Contra Costa County, although there is, no doubt, much stone valuable for building purposes. A fair quality of drab-colored freestone has been quarried at Martinez, both for local use and for shipment to Napa, where it has been used in the construction of the asylum. The buildings for which it was used in Martinez seem to prove it a durable stone. The better class of this freestone hardens under the action of the weather, while the facility with which it is cut greatly enhances its value as a building material. The quarry from which it is obtained is situated on the Barney Ranch, upon the western edge of the town of Martinez. The sandstone is here exposed for about thirty feet, in strata two to ten feet thick, which are separated from one another by thin strata of shale a few inches in thickness. This sandstone does not appear to contain fossils, and dips to the south at an angle of about fifty degrees. The quarry is situated about one mile from the river landing. Blocks four by ten by five feet could readily be obtained, costing, perhaps, 25 cents per cubic foot to quarry, or $1 free on board a schooner at the river landing. There is also said to be a good grade of building stone on the ranch of Joshua Marsh, two and one half miles southeast from Clayton; but at present this is rather too far from means of transportation to be of more than local value. Good basalt blocks have been quarried on the ranches of D. Matterson and J. Q. Blackmar, about three and one half miles southeast of Concord; this rock is of remarkably fine cleavage. The quarry on the Blackmar Ranch has been worked about three years, blocks being shipped from the Pacheco Landing, which is distant about six miles. Upon the surface the basalt is, in some places, vesicular, but a few feet beneath it becomes firm and compact. Little has been done with this rock on the ranch of D. Matterson.

MINERAL SPRINGS.

The most notable mineral waters of Contra Costa County are the Byron Hot Springs, although there are many others of local repute. In Pine Tree Cañon at the foot of Mount Diablo, are two sulphur springs, also several at Vaca Cañon, five miles from Martinez—Stewartsville, Walnut Creek, Marsh Creek, and Oil Cañon.

BYRON SPRINGS.

The springs are situated in a small valley leading from the San Joaquin plains westward toward Mount Diablo. The center of this valley is filled with a light-colored adobe clay, caused by the decomposition of the calcareous shales, of which a great portion of the neighboring hills are formed. This clay is covered in many places by sand, resulting from the disintegration of adjacent sandstones. It is in this clay that Byron Springs rise. There are twenty-six springs in this valley, varying in temperature from 65 degrees to 128 degrees F., and also in the character and quantity of the mineral constituents held in solution. For while in some the sulphuretted and saline properties are hardly perceptible, in others they are most pronounced. The medicinal virtues of these springs were well known to the Mexicans, and since the Byron Springs Hotel has been erected, numbers of invalids, for whose ailments the waters are a panacea, resort thither at all seasons of the year. Inflammable gas rises in such volumes from two borings in the clay to the south of the hotel, that it is the intention of the proprietor to utilize it for heating and lighting purposes. The neighboring hills are covered with alluvial soil, rendering geological investigation difficult. A cutting in the roadway east of the hotel discloses strata of limestone and calcareous shales, some of the latter being quite white and effervescing freely with acid. Still further to the east, a well has been sunk to the depth of about one hundred and twenty-five feet, and some sixty-five feet of fresh water have been obtained. The strata penetrated by this well dips to the northeast at an angle of about 60 degrees. The top stratum is a coarse sandstone, passing into a conglomerate and gravel; the latter is said to yield a few colors of gold. As there are no evidences of volcanic action in the vicinity of Byron Springs, the temperature of the water is probably due to chemical action, such as the decomposition of iron pyrites.

In boring for gas at Byron Springs, the strata passed through was: Soft clay, twenty-five feet; hard clay, fifteen feet; iron pyrites, one foot.

Beneath the mud bath at these springs is a limestone containing much sand, making a natural flowing, through which inflammable gas rises. It also escapes at many places in the adjacent marsh. A few feet east of the mud bath, a calcareous sandstone occurs, containing small shells which have not been discovered elsewhere upon the premises.

DEL NORTE COUNTY.

The name of this county signifies in the Spanish, "of the north," and indicates its location in the extreme northwest angle of the State. Its extent is one thousand five hundred and forty-six and eighty-seven one hundredths square miles, equal to nine hundred and ninety thousand acres. Two thirds of this area is mountainous, the remainder good, arable valley land. Nearly the entire surface of the county presents, in fact, a rugged

appearance, the northern extremity of the Coast Range here breaking into irregular ridges. There are many fertile valleys, however, with good grazing. Farming, stock raising, and dairying are the principal industries and are found to be profitable.

The county is bounded by the State of Oregon on the north; by Humboldt County and a portion of Siskiyou on the south; by Siskiyou on the east; and on the west by the Pacific Ocean. Del Norte is well wooded and watered. The Klamath, one of the largest rivers in the State, forms the southern boundary for more than a hundred miles, while the Smith, another important stream, flows centrally through the county toward the northwest. Both of these streams have numerous tributaries, some of large size. The rainfall is in excess of that of any other county in California.

Del Norte's geographical formation may be described as metamorphic slate, in contact and running parallel with a wide belt of serpentine. The trend of the strata is northerly and southerly. So far as minerals are concerned, the deposits are limited. The county has not been perfectly prospected in this respect, and mining industry, as a business, has not flourished.

The principal towns and mining camps are Crescent City (the county seat), Smith River, Gasquet, Requa, and Altaville, eight miles east of Smith River.

Copper and iron ores, as well as chrome, have been found at Altaville in considerable quantity. Plumbago has also been discovered at Gasquet, eighteen miles northeast from Crescent City. Placer mining is carried on at Gasquet, with some success. At Haynes and Big Flat, thirty-five miles distant, at the Bald Hills, on Smith River, veins carrying gold, silver, and copper exist.

EL DORADO COUNTY.

The name El Dorado, or golden region, was applied to this country because within its limits occurred the first great gold discovery in California. El Dorado County is bounded on the north by Placer, on the south by Amador, on the east by Alpine County and the State of Nevada, and on the west by Sacramento and Placer Counties.

Three fourths of this county, including the more mountainous parts, are heavily wooded, the timber consisting of stately forests of pine, spruce, and cedar. The balance is covered with a more scattered growth of oak and inferior pine, there being very little timber of any kind in the extreme western portion of the county. The Middle Fork of the American River separates this county from Placer, while the Cosumnes separates it from Amador. These rivers, with their numerous branches, constitute the principal streams found in El Dorado County. In the eastern part of the county, at an altitude of about six thousand feet, a number of lakes occur; Lake Tahoe, the most important body of water in California, being partly in this county.

MINES, MINING, ETC.

Besides numerous gold-bearing quartz leads and deposits of auriferous gravel, this county contains valuable deposits of useful minerals of various kinds. Among these are beds of marble of good quality and of many varieties, and extensive quarries of slate of a superior quality. This county bears a general resemblance, geologically, to the counties of Amador, Calaveras, and Tuolumne; similar volcanic formations occurring, but occupying a less extensive area than in Amador and Calaveras Counties; similar

belts of limestone traversing the county in the western portion, having a course a little east of north and a dip of about 50 degrees to the eastward; and the same granitic formation occupying the greater part of the eastern half of the county; while the same belt of auriferous rocks, from twenty-five to thirty miles in width, with a general trend of north, 27 degrees west, and dip of 65 degrees to 80 degrees easterly, occupies the middle portion of the county. The principal rocks occurring in this belt are the black slate and diorite of the mother lode, occupying the center, associated with some talcose slate; and the granite and diorite occupying the extreme eastern and western borders of the belt. The slate quarries, recently opened, are in the foot-wall rock of the mother lode, in localities where, though the dip is 75 degrees to 80 degrees from the horizontal, the finely laminated slate is very firm, and little altered in mechanical structure or chemical composition since its formation.

THE JOSEPHINE MINE.

This mine is situated in the Volcanoville Mining District, one quarter of a mile north of Volcanoville, eight miles northeast of Georgetown. The vein runs a trifle east of north and west of south, and dips easterly, at an angle of about 45 degrees, averaging about six feet in width. The claim is nine thousand six hundred feet long by one thousand two hundred feet in width. One ore shoot has been worked for two hundred feet in length, and the full length has not been determined, there being ore in each end, as far as exploration has advanced. Another shoot has just been encountered, of the length of which nothing is known definitely. The ore shoots on the mine pitch at about the same angle with the general trend as the vein dips with the horizon. At present the mine is worked through tunnels, and is admirably suited for this purpose. The lengths of these tunnels are as follows: No. 1, two hundred feet; No. 2, eight hundred feet; No. 3, one thousand four hundred and fifty feet; No. 4, one thousand one hundred and twenty feet; No. 5, two hundred and thirty feet. Levels Nos. 2, 3, and 4 are connected by winzes, the vertical depth reached below the surface being about eleven hundred feet. The shoots of ore occur in porphyritic material several hundred feet in width, inclosed on the hanging-wall side by slate, and on the foot by serpentine. About seven or eight inches of water find egress daily from the mine, by way of the numerous tunnels. About two hundred pounds of Hercules, No. 2, powder are consumed monthly. The cost of mining is from 85 cents to $1 per ton. The tunnels are timbered throughout with round pine timber. About one quarter of a mile of road was constructed by the company. The ore either comes from the upper tunnels direct to the works, or is elevated from the lower tunnel by a friction gear hoist. The ore is free milling, containing some sulphurets of iron and lead. It is treated by the usual free gold and concentrating process, in a water power mill, driven by a Knight four and one half-foot wheel, under about three hundred and twenty feet of pressure. The mill is equipped with a large rock breaker, ten eight hundred and fifty-pound stamps, and ten seven hundred and fifty-pound stamps, dropping, usually, six and one half inches, ninety-two times per minute, and crushing from forty to fifty tons in twenty-four hours. Brooklyn chrome steel is used for shoes and dies. About two inches of water are used in the battery. Angle slot screens, Nos. 5, 6, and 7, are employed, with a discharging surface for two of the batteries of nine inches by forty-two, and for the other two batteries six inches by forty-five. The screens are slightly inclined. The aprons connected with

each two batteries differ in size, two of them being twenty-eight by fifty inches, and two twenty-nine by fifty-four inches. The sluices (one to each battery) are fifteen inches wide and twenty-seven feet long. The plates inside of two batteries are five inches by forty-eight, and inside of the other two, three and three quarters inches by forty-two. The aprons have an inclination of two inches to one foot; the sluices one and three fifths inches. The mill is supplied with Challenge feeders. Of the gold present in the free state about 60 per cent is recovered in the battery, and 40 per cent on the outside plates. The sulphurets contained in the rock amount to over 2 per cent, and consist of pyrites and galena principally, and are saved on eight Triumph concentrators. It is intended to treat the sulphurets by chlorination process, and to this end a three-hearth roasting furnace is being constructed. Ten men are employed in the mine, besides the foreman; in the mill four; on outside work two, or a total of sixteen, besides the foreman. The usual wages are paid—$2 50 per day in the mine, $3 per day in the mill, and $2 per day for outside work. No wood is used at present, as all the machinery is driven by water power; but an abundance of pine wood is available at $2 per cord. The pressure of water on the wheel at the friction hoist is about three hundred feet; the size of the wheel, forty-two inches in diameter; the size of wire rope employed, three quarters inch. By means of this hoist the ore is raised in cars from the mouth of the main tunnel to the track leading to the mill. Water for power and milling is purchased from the California Water Company at reasonable rates.

Altitude (aneroid reading)	2,750 feet.
Length of ore shoot	200+ feet.
Length of ore shaft on incline	146 feet.
Vertical depth reached in mine	1,100 feet.
Quantity of water raised in twenty-four hours (egress from tunnels)	120,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Serpentine.
Kind of powder used	Hercules, No. 2.
Quantity of powder used	200 pounds monthly.
Cost of mining	85 cents to $1 per ton.
Number of feet timbered	All.
Kind of timber	Round pine.
Length of road built	¼ mile.
Character of ore	Free milling.
Character of works	Water power mill, with concentrators.
Number of stamps	20
Weight of stamps	Ten of 850 pounds, and ten of 750 pounds.
Drop of stamps	6½ inches.
Drops	92 per minute.
Duty of stamp	2¼ tons in twenty-four hours.
Kind of shoes and dies	Brooklyn chrome steel.
Size and character of screens	Angle slot, Nos. 5, 6, and 7.
Water used in battery	4 miner's inches.
Dimensions of aprons	Two aprons 28 by 50 inches, and two 29 by 54 inches.
Width of sluice	15 inches.
Length of sluice	27 feet.
Kind of feeder	Challenge.
Kind of concentrators	Triumph.
Percentage of gold saved in battery	60
Percentage of gold saved on plates	40
Percentage of sulphurets	2 to 3
Number of men in mill	4
Number of men in mine	10
Total number employed	16
Average wages in mine	$2 50 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 per day.
Cost of wood	$2 per cord.
Quantity of water used in milling	4 inches.
Head of water used for power	At hoisting works, 290 feet; at mill, 320 feet
Water used for power	72 miner's inches.

UNION CONSOLIDATED COMPANY—ALPINE MINE.

This company owns six claims (one thousand five hundred by six hundred feet each) in the Garden Valley District, about two and one half miles southwest of Georgetown. The mine now being worked is the Alpine, which has a course north 25 degrees west, dipping easterly about 60 degrees from the horizon, and is about eight feet in width. There are two shoots on the mine—one two hundred and thirty feet in length, and the other one hundred, with about four hundred feet of intervening ground. The mine is worked through a cross tunnel two hundred and fifty feet long, attaining a vertical depth from the surface of about one hundred and forty feet, and by a vertical shaft one hundred feet deep. The walls are slate. The mine is relieved of about twenty-nine thousand gallons of water every twenty-four hours by means of a Dowe steam pump, No. 3, with a two and one half-inch column. Safety Nitro powder is used at the rate of about twenty-four hundred pounds yearly, and Black Diamond steel, costing 9 cents per pound delivered, is annually consumed at the rate of about one thousand pounds. The cost of mining per ton may be roughly stated at $1, while the contract price of running the tunnel, in which about one foot per man employed was the average progress, was $4, including powder and tools. The shaft, which is four by six feet in the clear, and sunk on the vein, and in slate, and timbered with six by eight-inch sawed pine timber, cost $14 per foot, and was excavated at the rate of three feet per day. Only thirty or forty feet of the tunnel required timbering. Lagging costs at the mine $25 per thousand. Fine timber, which abounds in large quantities at the mine, is delivered at $15 per thousand feet; round timbers, at 4 cents per running foot. The company built three fourths of a mile of road, one mile of ditch, and put in one thousand feet of pipe fifteen inches in diameter, constructed of No. 14 iron. A car man conveys the ore from the mine, over a tramway three hundred and fifty feet in length, to the mill. The ore is a soft quartz, containing fine gold, and from 1½ to 2 per cent sulphurets, and the loss in tailings is stated to be 40 cents per ton. The ore is reduced in a wet crushing stamp mill, with batteries running with four-inch discharge. Amalgamation is not performed in the battery, but only on outside plates, which are cleaned up every morning, quicksilver, however, being introduced into the batteries. The sulphurets are recovered in three Duncan concentrators. The mill, which is driven by water power, under two hundred and eighty-six feet of pressure applied to a four-foot Pelton wheel, contains a Blake crusher, nine by fifteen inches, driven by a separate Pelton wheel, eighteen inches in diameter, Challenge feeders, ten stamps of one thousand pounds each, with a four-inch drop, and speed of one hundred per minute, crushing three and one half tons each in twenty-four hours. Chrome steel shoes and dies are employed, at a cost of 8 cents per pound. Five inches of water are used in the battery.* The screens, which are straight one half-inch slot, No. 7, and steel wire, No. 30 mesh, are eighteen by forty-eight inches in diameter, and placed nearly vertically. No plates are used inside of the battery. The aprons and sluices are covered with copper, and have an inclination of two inches to one foot. The concentrates recovered consist chiefly of iron pyrites, with some silica, and will be worked on the ground, probably by pan amalgamation. Fourteen men, including the foreman, are employed in the mine,

*El Dorado County custom is variable as regards to what constitutes the miner's inch. The measure here given is six inches above the top of a two-inch slot in one and one half-inch plank. The stamps have an order of drop 2, 4, 1, 5, 3 in one battery, and reverse in the next. The amalgam retorts a little less than one half.

two in the mill, and three on outside work. The wages in the mine are $2 50, in the mill $3, and outside $2. The hoisting works are equipped with portable straight gear machinery, upright boiler, and double cylinder engine, six by ten-inch, requiring about one cord of pine wood per day, at a cost of $1 62½. It is proposed to sink the shaft five hundred feet vertically; to put in water power, and machinery capable of going down one thousand feet; and erect fifteen more stamps as soon as the mine is sufficiently opened.

Altitude (aneroid reading)	2,030 feet.
Length of ore shoots { one	230 feet.
Length of ore shoots { one	100 feet.
Depth of ore shaft vertically	100 feet.
Vertical depth reached in mine	340 feet.
Quantity of water raised in twenty-four hours	28,800 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Safety Nitro.
Quantity of powder used	200 pounds per month.
Cost of mining	$1 per ton.
Cost of tunnel	$4 per foot, without timber.
Cost of shaft	$14 per foot.
Number of feet timbered	All.
Kind of timber used	Sawed pine.
Cost of timber	Sawed, per thousand feet, $15; round, 4 cents per running foot; lagging, $25 per thousand.
Length of road built	Three quarters of a mile.
Length of ditch built	1 mile.
Cost of transport of ore	5⅝ cents per ton.
Character of ore	Free milling.
Character of works	Wet crushing, gold mill.
Number of stamps	10
Weight of stamps	1,000 pounds.
Drop of stamps	4 inches.
Drops	100 per minute.
Duty of stamp	3½ tons in twenty-four hours.
Kind of shoes and dies	San Francisco Rolling Mill's steel.
Size and character of screens	Straight half inch slot, No. 7, and steel wire screens, 30 mesh.
Water used in battery	5 miner's inches.
Dimensions of apron	2 by 12 feet.
Width of sluice	2 feet.
Length of sluice (two to each battery)	10 feet.
Kind of feeder	Challenge.
Kind of concentrators	Duncan.
Percentage of sulphurets	1½ to 2
Value of sulphurets	$70 per ton.
Cost of milling	50 cents per ton.
Number of men in mill	2
Number of men in mine	14
Number of men employed on outside work	3
Total number employed	19
Average wages in mine	$2 50 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 per day.
Wood used	1 cord per day.
Cost of wood	$1 62½ per cord.
Quantity of water used in milling	5 miner's inches.
Head of water used for power	286 feet.
Water used for power	30 miner's inches.
Cost of water for milling, at 10 cents per inch	50 cents.
Cost of water for power, at 10 cents per inch	$3

THE TAYLOR MINE.

This mine is situated in the Greenwood Mining District, three miles south of east from Greenwood, three and one half miles southwest of Georgetown, and about fourteen miles west of north from Placerville. It was located about fifteen years ago. The course of the vein is south of east and west of north, and the dip is easterly, at an angle of about 50 degrees with the

horizon, and its average width is about ten feet. The dimensions of the claim, which is covered by United States patent, are twelve hundred feet in length by six hundred feet in width; the length of the ore shoot is five hundred feet. and continues as far as explored. The mine is worked by an incline shaft five hundred and twelve feet deep, measured on its angle of inclination, which gives a perpendicular depth of about four hundred feet. The hanging-wall is black slate, and the foot-wall is diorite, usually called greenstone on the mother lode. The small quantity of water coming in the mine is raised by a plain Cornish jackhead seven-inch pump, with a thirty-inch stroke, thirty strokes per minute while running, but only used a very small fraction of the day. The company has a Burleigh compressor on hand, and drills, but no use has, as yet, been made of them. One hundred pounds of Hercules powder, No. 2, are used monthly, and during the last six months $50 worth of drill steel was consumed. The mining has been performed for $3 per ton, including dead work, but this ore can be mined for about $2 50. The cost of running the levels is about $5 per foot. without powder or timber; two feet per day are usually driven in the levels. The last one hundred feet of the shaft, which is five by ten feet in the clear, cost $55 per foot. The shaft was sunk for three hundred feet through vein matter, but the two hundred feet last sunk are almost entirely in greenstone. The shaft is timbered entirely with eight by twelve-inch sawed pine timber, which costs, delivered, $16 per thousand feet; round timbers, according to size, are procured for from 4 to 5 cents per running foot, and five-foot lagging costs $40 per thousand. An abundance of timber grows right at the mine. The company has constructed three hundred feet of ditch and laid two thousand feet of eleven-inch pipe, constructed of Nos. 16 and 14 iron. As the mine and mill are in immediate proximity, there is no cost for transportation of the ore, which is free milling and sulphuret-bearing, and is submitted to the ordinary free gold treatment, in a wet crushing mill, driven by water power applied to a three-foot Pelton wheel, under a pressure of two hundred and twenty feet, the rock breaker running by a separate wheel eighteen inches in diameter. The mill contains ten stamps, weighing seven hundred and fifty pounds each, dropping four to five inches, ninety-four times per minute, and crushing about one ton to the stamp; iron shoes and dies are used, costing 5½ cents per pound, with 1¾ cents returned for old iron, and last about forty days. Four hundred tons of ore in being crushed wear out one thousand two hundred and fifty pounds of shoes and eight hundred and fifty pounds of dies—two thousand one hundred pounds of iron. Two thousand one hundred pounds of iron, at 5½ cents, $115 50; four hundred and twenty pounds (one fifth weight) returned, at 1¾ cents, $7 35; net expense of iron shoes and dies for four hundred tons of ore, $108 15; equivalent to 27 cents per ton.

No. 8 straight half inch slot screens are used, eight by forty-eight inches inside of the frame, which is slightly inclined. Thirty-six by forty-eight-inch aprons are employed. There are two sluices to each battery, twenty inches in width and eight feet long. A front and back plate, each very slightly inclined from the vertical, and six inches wide, and forty-eight inches long, are used inside of the battery; the outside plates are of plain copper and incline one and one quarter inches to one foot. The mill is furnished with two Challenge feeders. Of the value recovered, 75 per cent is obtained in the battery; 23 per cent on the outside plates; and 2 per cent in the barrel in which the "blanket washings" are treated. The loss of quicksilver amounts to one pound for every ten tons of ore crushed; or one tenth of a pound to the ton of ore; or about 6½ cents. The ore contains about 2 per cent of iron sulphurets; the lowest containing $86 per ton, and the highest

$111; usually containing about $100 per ton. The grade of gold recovered by the present process is from 810 to 820 fine. There is no separate item of cost made in the accounts for the treatment of sulphurets. It is not known to what percentage the blanket washings are worked; nor what is the gold content of the tailings. The inference to be drawn from the loss of quicksilver is that the loss of gold is considerable. The number of men in the mine is eleven; in the mill, two; and three are employed on outside work (one man on the rock breaker, one "bucket lander," and one blacksmith). The wages paid in the mine are $2 50 per day; in the mill, $3; and for outside work, $2 and $2 50 per day. No wood is used for power at either the mine or the mill; but an abundance of pine or oak wood could be procured for $3 per cord, if desired. A four-foot Pelton wheel, under two hundred and twenty feet of pressure, drives the hoisting works, consisting of friction gear and single thirty-inch reel, a three quarter-inch flexible steel wire rope being used. The hoisting works take about twenty miner's inches of water, or about the same quantity as is required for the mill. The measurement allowed here for the miner's inch is a six-inch pressure above the top of a two-inch opening in a one and one half-inch plank. Water is furnished at the rate of 15 cents per inch, for twenty-four hours. There were originally five levels in the mine; one at one hundred, one at two hundred, one at three hundred and twenty, one at four hundred, one at five hundred feet, respectively, from the surface. The one hundred-foot level has been worked out and is not open. The two hundred-foot level has been stoped for about fifty or sixty feet in length, and from twenty to eighty feet in height; it is open for one hundred feet north. The three hundred and twenty-foot level is driven fifty feet to the north, and forty feet to the south. The four hundred-foot level extends north one hundred and eighty feet, and south, three hundred and forty. The five hundred-foot level runs south one hundred feet, and is still being driven; the uprise from the five hundred-foot level is but eight feet in height. The stopes on the four hundred-foot level vary in height from fifteen to eighty feet north of the shaft; very little ore is stoped from the four hundred-foot level south of the shaft. Two hundred feet south of the shaft, Uprise No. 1 has reached a height of about thirty feet. Uprise No. 2, sixty feet south of No. 1, has reached a height of forty feet; but no stoping has been done at this point.

During the year all of the "five hundred" drift has been driven, and the above described uprises have been made; the four hundred-foot level has been extended about two hundred feet; the three hundred and twenty-foot level has been driven ninety feet, and the mill and hoisting works principally constructed. The company commenced to reopen the mine, which was an old one, in January, 1888. The pressure of water can be doubled by constructing and laying from eighteen hundred to two thousand feet of pipe. Work is never interrupted on account of weather. It is proposed to erect a thirty-stamp modern mill, and equip it with Frue concentrators; increase the shaft to two compartments; lay about eighteen hundred feet more of pipe, and thereby secure four hundred and fifty feet of water pressure.

The cost of milling: Water, per ton of ore, 30 cents; labor, 30 cents; shoes and dies, 27 cents: quicksilver, 7 cents; outside labor (rock breaker), 20 cents; screens, 2 cents; other incidentals, 4 cents; total, per ton of ore, $1 20.

Altitude (aneroid reading)	2,000 feet.
Length of ore shoot (as far as explored)	500 feet.
Length of ore shaft on incline	512 feet.
Vertical depth reached in mine	About 400 feet.
Quantity of water raised in twenty-four hours	300 gallons.
Character of hanging-wall	Black slate.

Character of foot-wall	Diorite (greenstone).
Kind of powder used	Hercules, No. 2.
Quantity of powder used	100 pounds monthly.
Cost of mining (including dead work)	$3 per ton.
Cost of tunnel, for labor	$5 per foot.
Cost of shaft, for last 100 feet	$55 per foot.
Number of feet timbered	All.
Kind of timber	8 by 12-inch sawed pine.
Cost of timber	For sawed, $16 per thousand; for round barked logs, 4 cents per running foot; for lagging, $40 per thousand.
Length of ditch built	300 feet.
Character of ore	Free milling, with sulphurets.
Character of works	Free gold water mill.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamps	4 to 5 inches.
Drops	94 per minute.
Duty of stamp, with present size of screen	1 ton in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Straight $\frac{1}{8}$-inch slot, No. 8.
Dimension of apron	36 by 48 inches.
Width of sluice	20 inches.
Length of sluice (double)	8 feet.
Kind of feeder	Challenge.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	23
Percentage of sulphurets	2
Value of sulphurets	$100 per ton.
Cost of milling	$1 20 per ton.
Cost per ton of working sulphurets	Included in milling.
Number of men in mill	2
Number of men in mine	11
Number of men employed on outside work	3
Total number employed	16
Average wages in mine	$2 50 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 and $2 50 per day.
Head of water used for power	220 feet.
Water used for power	At hoisting works, 20 miner's inches; at mill, 20 miner's inches.
Cost of water for power	15 cents for 40 inches per day, $6

THE ROSECRANS MINE.

This mine adjoins the Taylor Mine on the south, and is controlled by the owners of that mine. The vein is a north and south vein, and where opened the dip was to the west about forty feet, in an incline of two hundred and four feet; the average width is three to four feet. The dimensions of the claim are fifteen hundred and seventy feet in length, and six hundred in width. The mine is so situated in respect to the Taylor that it includes within its limits the extension of the Taylor vein, and the Taylor includes the extension of the Rosecrans vein, the two mines having been opened on parallel veins. There are three levels on the mine, at one hundred, one hundred and thirty, and two hundred feet, respectively, from the surface. On the one hundred-foot level, the north drift is forty-eight feet, and the south drift fifty-five feet in length at one hundred and thirty feet from the surface, there is a drift run north one hundred and thirty feet, and south one hundred and forty-two feet; on the two hundred-foot level, the north drift is forty-three feet, and the south drift forty-nine feet in length. It is said that the shaft and drifts are in ore, and that the average grade of ore extracted, without selection, was over $10 per ton. The walls are diorite. The hoisting works are provided with a twelve by twenty-four engine. The Rosecrans has a steam power, free gold mill, with ten stamps, weighing eight hundred pounds each, driven by a fourteen by thirty-two-inch engine.

VANDALIA MINE.

This mine was located in 1885, and is situated in the Pekin District, four and one half miles south of Shingle Springs. The course of the lead is north and south, and the dip is nearly vertical, but slightly inclining toward the east. The average width is twenty feet. The dimensions of the claim are one thousand three hundred and twenty feet by eight hundred feet, and there are two ore shoots—one, one hundred feet in length, and the other fifty. The mine is worked through a tunnel, three hundred feet in length, reaching a vertical depth of one hundred and ten feet from the surface on the one hundred-foot shoot, and seventy-five feet from the surface on the fifty-foot shoot. From the main shoot a winze is sunk, nearly vertically, fifty-eight feet below the tunnel, or to a depth of one hundred and sixty-eight feet from the surface. The walls are porphyritic in their nature. In the spring the mine yields about fifty-one thousand gallons of water; during the summer and autumn the usual inflow is about thirty-four thousand gallons daily. A No. 6 Cameron steam pump, with three-inch suction and two-inch discharge, handles the water. About one hundred and fifty pounds of Safety Nitro powder, No. 2, are consumed monthly. Mining, milling, and transportation of ore costs $3 per ton; of this sum mining expense amounts to $1 40, transportation 10 cents, and milling $1 50 per ton. The expense of running tunnels is $3 50 per foot, including everything. The expense of sinking the winze, which is four by six feet in the clear, is $15 per foot. Round timber is generally used, costing 5 cents per running foot, sizes from eight to twelve inches in diameter at the smaller end being usually employed. The timber is hauled two miles.

The ore is partly honey-combed quartz, and partly very heavily sulphureted rock. The ore is stamped in a mill, and amalgamated in the battery and on outside plates. The mill contains five stamps of eight hundred and fifty pounds each, and two Frue concentrators; the stamps have a four-inch drop and fall ninety times per minute, crushing fourteen tons, on the average, in twenty-four hours. Iron shoes and dies, costing 5 cents per pound, have been used until recently; but steel, costing 8 cents per pound in San Francisco, has been substituted. A set of iron shoes and dies lasts seventy days, crushing nine hundred and eighty tons of ore; or about one and one third pounds of iron, costing 6⅔ cents, are consumed in crushing a ton of ore. A little less than one and one half inches of water are used in the battery, for which $2 per day are paid, from July until September, during the period of greatest scarcity of water, and $1 50 per day during the other portion of the year. The screens are angle slot, No. 8, ten inches by three feet eleven inches, inside the frame, which is slightly inclined; the width of the mortar, in the bottom, is thirteen and one half inches, at the level of discharge is sixteen and one half inches; the apron, having an inclination of two inches to one foot, is four feet two inches wide and four feet long. The sluice, with a grade of two and one half inches to one foot, is four feet wide and twenty-one feet long. The plate inside the battery is curved, and is forty-eight inches long and six inches wide, measured on the curve; the outside plates are silvered with one and one half ounces of silver to the square foot; and the mill is supplied with a Challenge feeder. Fifteen per cent of the free gold is recovered in the battery and 85 per cent on the outside plates. About fifteen pounds of quicksilver are lost monthly, or about fifty-seven one hundredths of an ounce for each ton of ore worked, or about 2½ cents per ton are lost in quicksilver. Five per cent of sulphurets are saved on Frue concentrators, and shipped to the Selby Works, at Vallejo

Junction, at an expense of $1 75, teamster's freight, $4 50 railroad freight, and $18 treatment, 90 per cent of the gold value being allowed. Fourteen men are employed, ten in the mine at from $2 50 to $3 per day, and four in the mill at $3 per day. One and one half cords of pine or oak wood, at a cost of $3 25 per cord, are consumed per day at the boiler, which is forty-two inches in diameter and sixteen feet long. The engine has a cylinder ten inches in diameter and a twelve-inch stroke. Nearly all of the developments have been made during the last year and consist, besides the tunnel and winze, of a crosscut fifty feet east from the bottom of the winze, and two hundred feet of other drifts and crosscuts.

The milling expense, which is about $1 50 per ton, may be segregated as follows: Labor, 85.8 cents; wood, 34.8 cents; water, 14.3 cents; quicksilver, 2.5 cents; shoes and dies, 6.6 cents; screens, 1 cent; incidentals, 5 cents; total, $1 50.

Altitude (aneroid reading)	1,290 feet.
Length of ore shoots { one	100 feet.
Length of ore shoots { the other	50 feet.
Length of ore shaft on incline	58 feet.
Depth of ore shaft vertically	58 feet.
Vertical depth reached in mine	168 feet.
Depth of water shaft	168 feet.
Quantity of water raised in twenty-four hours	31,000 to 51,000 gallons.
Character of hanging-wall	Porphyritic rock.
Character of foot-wall	Porphyritic rock.
Kind of powder used	Safety Nitro, No. 2.
Quantity of powder used	150 pounds per month.
Cost of mining	$1 65 per ton.
Cost of tunnel	$3 50 per foot.
Cost of shaft	$15 per foot.
Number of feet timbered	All.
Kind of timber used	Round pine.
Cost of timber	Lagging, $80; sawed lumber, $20 per thousand; round timber, 5 cents per running foot.
Length of road built	Half a mile.
Cost of transport of ore	10 cents per ton.
Character of ore	Free milling, and sulphureted.
Character of works	Wet crushing, steam power gold mill.
Number of stamps	5
Weight of stamps	850 pounds.
Drop of stamps	4 inches.
Drops	90 per minute.
Height of discharge	4 inches.
Duty of stamp	2⅖ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Angle slot, No. 8.
Water used in battery	1½ miner's inches.
Dimensions of apron	48 by 50 inches.
Width of sluice	4 feet.
Length of sluice	21 feet.
Kind of feeder	Challenge.
Kind of concentrators	Frue.
Percentage of gold saved in battery	15
Percentage of gold saved on plates	85
Percentage of sulphurets saved	5
Value of sulphurets	$100 per ton.
Cost of milling	$1 50 per ton.
Cost of working sulphurets	$24 25 per ton.
Percentage of value extracted from sulphurets	90 allowed.
Number of men in mill	4
Number of men in mine	10
Total number employed	14
Average wages in mine	$2 50 to $3 per day.
Average wages in mill	$3 per day.
Wood used	1½ cords per day.
Cost of wood	$3 25 per cord.
Quantity of water used in milling	1½ miner's inches.
Cost of water for milling	$2 per day.

BIG CAÑON GOLD MINING COMPANY.

The property of this mining company is situated in the Pekin Mining District, five miles south of Shingle Springs. The vein has a northerly and southerly course and easterly dip of 45 degrees, and an average width of from thirty to forty feet. The size of the claim is seventy-three acres, and the length of the shoot is stated to be eleven hundred feet. The mine is opened by a vertical shaft one hundred and sixteen feet deep, and by two tunnels, one forty and the other sixty feet in length, the latter attaining a vertical depth of fifty feet from the surface. The shaft yields about four hundred gallons of water per day, which is removed with a forty-four-gallon bucket. About three hundred pounds of Giant, No. 2, powder and two hundred pounds of Judson powder are consumed monthly, and about twenty pounds of steel. Mining costs 70 cents per ton. About two feet per day were driven in the tunnels, at a cost of $6 per foot. The cost of sinking the shaft, which was nine by fifteen feet in the clear, and did not require timbering, was $31 per foot, the formation passed through being serpentine. The tunnels are timbered throughout with round pine timber, which is hauled two miles, and costs 5 cents per running foot. The company built about one half mile of road, and owns, by purchase, five miles of ditch capable of carrying one hundred and twenty miner's inches of water. The ore is conveyed by car over a tramway to an elevator, thence raised to the rock breaker at a total expense of about 5 cents per ton. The ore is crushed under stamps, amalgamated in the battery and on outside plates. The mill contains a Blake rock breaker and twenty stamps weighing eight hundred and fifty pounds each, dropping six inches, ninety-five to one hundred and four times per minute, and crushing about two and one half tons per stamp. Iron shoes and dies are used, costing 4 cents per pound, and lasting sixty days. The wear is about five thousand pounds of iron to three thousand tons of ore crushed, or about one and two thirds pounds of iron to the ton of ore, equivalent to a cost of 6⅔ cents per ton. It is intended to substitute steel for iron, and by experiment to determine the comparative expense of the two materials. About four miner's inches of water are used in the batteries. The screens are No. 8 angle slot, having a discharging surface of ten by forty-eight inches, and slightly inclined from the perpendicular. The aprons, having an inclination of one and one half inches to one foot, are forty-eight inches by fifty. The sluices, which are fifteen inches wide and nineteen feet in length, have the same inclination as the aprons, and all are covered with electroplate. The size of the plate, inside of the battery, is forty-eight inches by six inches, measured on a curve line. Four Challenge feeders are used. Of the value in free gold 50 per cent is recovered in the battery and 50 per cent on the outside plates. The ore contains 1 per cent of iron pyrites, varying in value from $50 to $100 per ton. These sulphurets are recovered on eight Triumph concentrators, with which the mill is provided, and shipped to the Selby Smelting Works at the following cost per ton: Team freight to Shingle Springs, $1 75; railroad freight to smelting works, $4 50; charges for treatment, $18; total, $24 25. Fourteen men are employed in the mine, white men at the rate of $2 50 per day, Chinamen at $1 50. Five men are employed in the mill, at from $2 50 to $4, daily wages. At the shaft a miner's horse power hoist whim, capable of sinking three hundred-feet, is employed. At the mill water is used for power, and it is applied under three hundred and sixty-five feet of pressure to a three-foot Pelton wheel, driving the main machinery, and to a two-foot Pelton wheel driving the rock breaker. Water is supplied at the rate of 15 cents per miner's inch.

All developments and improvements have been made during the last two years. It is proposed to erect new water power friction gear hoisting works and chlorination works, for treating concentrations. The milling expense, per ton, may be segregated as follows: Labor, 30 cents; water, 18 cents; shoes and dies, 7 cents; incidentals (screens, lights, oil, quicksilver, etc.), 5 cents; total, 60 cents.

Altitude (aneroid reading)	840 feet.
Length of ore shoot	1,100 feet.
Depth of ore shaft vertically	116 feet.
Vertical depth reached in mine	116 feet.
Depth of water shaft	116 feet.
Quantity of water raised in twenty-four hours	400 gallons.
Character of hanging-wall	Serpentine.
Character of foot-wall	Black slate.
Kind of powder used	Giant, No. 2, and Judson.
Quantity of powder used	300 pounds Giant, No. 2, and 200 pounds Judson, monthly.
Cost of mining	70 cents per ton.
Cost of tunnel	$6 per foot.
Cost of shaft	$31 per foot.
Cost of timber	5 cents per running foot for round, $20 per thousand for sawed.
Length of road built	½ mile.
Length of ditch built	Own 5 miles.
Cost of transport of ore	5 cents per ton.
Character of ore	Free milling and concentrating.
Character of works	Water power gold mill.
Number of stamps	20
Weight of stamps	850 pounds.
Drop of stamps	6 inches.
Drops	95 to 104 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	Iron.
Size and character of screens	No. 6 angle slot.
Water used in battery	4 miner's inches.
Dimensions of apron	48 by 50 inches.
Width of sluice	(Double sluice) 15 inches.
Length of sluice	19 feet.
Kind of feeder	Challenge.
Kind of concentrators	Triumph.
Percentage of gold saved in battery	50
Percentage of gold saved on plates	50
Percentage of sulphurets	4
Value of sulphurets	$50 to $100 per ton.
Cost of milling	60 cents per ton.
Cost of working sulphurets	$24 25 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	5
Number of men in mine	14
Total number employed	19
Average wages in mine	$1 50 to $2 50 per day.
Average wages in mill	$2 50 to $4 per day.
Quantity of water used in milling	4 miner's inches.
Head of water used for power	365 feet.
Water used for power	60 miner's inches.
Cost of water for milling	4 inches at 15 cents, 60 cents.
Cost of water for power	56 inches at 15 cents, $8 40

GOPHER AND BOULDER MINE.

This mine is situated in the Kelsey Mining District, about seven miles northwest of Placerville. The course of the vein is a little west of north, and the dip is easterly, at an angle of about 65 degrees from the horizontal, the average width being not less than thirty feet, and in some places attaining a width of one hundred feet. The claim is three thousand feet in length by three hundred in width. The mine is opened by an incline shaft two hundred feet deep, corresponding to a vertical depth of one hundred and eighty feet from the surface, and an open cut, two hundred feet in length, attaining a vertical depth of about forty feet. The hanging-wall is a diorite

(greenstone); the foot-wall is said to be slate. The drilling is mostly done by machinery; the Rix & Firth compressor, and National drill being employed. The average consumption of powder, Safety Nitro, No. 2, amounts to one thousand, and sometimes one thousand five hundred pounds per month. The average cost of mining in the open cut is about 20 cents per ton; underground, from $1 25 to $1 50. The cost of sinking the shaft, the dimensions of the excavation being six by twelve feet, has amounted to $16 per foot. From two to two and one half feet were sunk per day with power drills. Though the formation passed through was vein matter, from its nature no timbering was necessary. However, as regards the occurrence of timber, the mine is most admirably situated. Sawed lumber can be procured for $16 per thousand; and round timbers, sixteen feet long, for $1 each, taking the entire tree. The company has built one mile of road, and one mile of ditch, having a capacity of about one thousand miner's inches of water, which is supplied from Rock Creek. Hitherto the treatment of the ore has been by the ordinary wet crushing and amalgamating process, but it is intended to put in pans and settlers and adopt the "Boss" system of milling.

The company's free gold mill runs by water power applied to a six-foot Knight wheel, under three hundred and twenty feet of pressure; a separate wheel, a Pelton, twenty-two inches in diameter, drives the rock breaker. Twenty-seven hundred and fifty-pound stamps, dropping four inches, one hundred times per minute, with a use of six to eight inches of water, and "tin" screens, corresponding to No. 6 angle slot, crush three and one half to four tons of rock in twenty-four hours. White iron shoes and dies, costing 6 cents per pound, usually last thirty days. The screens, which are nine by forty-eight inches, measured inside of the frames, are slightly inclined; the aprons are forty-eight by forty-two inches, and the blanket sluices used below them are fifteen inches in width and twelve feet long, all with an inclination of two inches to one foot. The Templeton, or roller feeders, are employed. At present all value is saved in the batteries and on outside plates, about one third of it inside. No record is at hand of loss of quicksilver in working, but according to the statement of the Superintendent, only about one half of the quicksilver used is recovered, which implies a large loss of gold in working. Fifteen men are employed in the mine, including the foreman, three in the mill, and five on outside work, or a total of twenty-three. The average wages paid per day are: $2 50 in the mine; in the mill, $3; engineers receive $3; blacksmiths, $3 50, and men engaged in general outside work, from $2 to $2 50 per day. At the hoisting works two cords of pine wood, costing $2 per cord, are used daily. The engine has a cylinder thirteen inches in diameter, and three-foot stroke; the dimensions of the boiler are fifty-four inches in diameter, and sixteen feet in length. The developments, other than the incline and open cut, consist of three levels—one at seventy-five feet from the surface, one hundred and fifty feet in length, connecting with the surface, and acting as an adit level; the second at one hundred and forty feet in depth, runs north seventy-five feet, and south sixty feet; the third, at two hundred feet, has been driven north fifty-five, and south thirty feet. The open cut and lower levels are the developments of the past season. It is now proposed to run all the machinery by electricity, the ditch having been constructed with this view. A dynamo will be placed at the end of the ditch, three miles from the mine, under a pressure of about two hundred feet, and it is calculated that a volume of twelve thousand gallons of water per minute will be available. It is intended to transmit one hundred and fifty-horse power to this company's mine and mill, and an equal amount to the Dal-

matia, situated one and one half miles nearer the dynamo. It is also in contemplation to introduce incandescent lights in the mine and mill, which is to be equipped with twelve pans and six settlers, and after the introduction of the Boss system of milling, battery amalgamation will be abandoned. This company, termed the "Gopher Boulder Mining Company," is a London incorporation; Post Office address, Kelsey.

Altitude (aneroid reading)	2,000 feet.
Length of ore shoot in aggregate (five shoots)	600 feet.
Length of ore shoot on incline	200 feet.
Depth of ore shaft vertically	180 feet.
Vertical depth reached in mine	180 feet.
Quantity of water raised in twenty-four hours	200 gallons.
Character of hanging-wall	Diorite (greenstone).
Kind of powder used	Safety Nitro, No. 2.
Quantity of powder used	1,000 to 1,500 pounds monthly.
Cost of mining	From 20 cents to $1 50 per ton.
Cost of shaft	$16 per foot.
Kind of timber	Pine.
Cost of timber	$16 per thousand feet.
Length of road built	One mile.
Length of ditch built	One mile.
Character of ore	Free milling.
Character of works	Wet crushing water power gold mill.
Number of stamps	20
Weight of stamps	750 pounds each.
Drop of stamps	4 inches.
Drops	100 per minute.
Duty of stamp	3¼ to 4 tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	No. 0 round punched.
Water used in battery	6 to 8 inches.
Dimensions of apron	48 by 42 inches.
Width of sluice	15 inches
Length of sluice	12 feet.
Kind of feeder	Templeton (roller).
Percentage of gold saved in battery	33⅓
Percentage of gold saved on plates	66⅔
Number of men in mill	3
Number of men in mine	15
Number of men on outside work	5
Total number employed	23
Average wages in mine	$2 50 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 to $3 50 per day.
Wood used	2 cords per day.
Cost of wood	$2 per cord.
Quantity of water used in milling	6 to 8 miner's inches.
Head of water used for power	320 feet.
Quantity of water used for power	71 miner's inches.
Cost of water for milling	20 cents per inch, $1 40 per day.
Cost of water for power	313 inches, at 20 cents per inch, $62 60 per day.

THE DALMATIA GOLD MINING COMPANY (LIMITED).

This company owns a mine and mill, in the Kelsey District, about eight miles northwest of Placerville. The mine is in a diorite formation, and is situated about one and one half miles from the Gopher and Boulder Mine. At present the mine and mill are equipped with steam plant, but are to be supplied with power from a dynamo, which will be placed about a mile and a half from the mine. The mill consists of a Dodge rock breaker, ten stamps weighing eight hundred and fifty pounds each, and Challenge feeders. This property is incorporated in London; its Post Office address is Kelsey.

GRIZZLY FLAT DISTRICT.

The Melton Mine is about the only one running in this district at present, though there have been several mines in active operation at different times,

some of them profitable. If developments are not made in advance of the requirements of mills, when veins become narrow at any time, between granite walls, the chances are in favor of a cessation of work at the mines and mills, on account of the expense of development. There are three parallel leads in the Grizzly Flat District, running in a belt of less than one thousand feet in width, with a northerly and southerly course, and inclosed in granite walls.

The first mine on the southern end of this belt, having any importance, is the Valdora, a claim one thousand five hundred feet in length and six hundred feet in width, with a shaft one hundred and ten feet deep, sunk nearly vertically. Then the Mount Pleasant, a claim four thousand five hundred feet in length, now temporarily idle, with a vertical shaft seven hundred feet deep, and two other shafts, one hundred and two hundred feet, respectively, and a tunnel four hundred feet in length. There is in connection with the mine a twenty-stamp steam mill, with Challenge feeders and eight Frue vanners. Next, northerly, are situated the Morey Mine and five-stamp mill, worked periodically for several years, the mine being opened entirely by tunnel. Lying next north of this is the Eagle, four thousand five hundred feet in length and five hundred feet in width, carrying from 2 to 5 per cent of sulphurets in value from $100 to $200 per ton, until the belt passes the South Fork of the Cosumnes River, when the sulphurets decline in value to $50. Next north of the Eagle lies the Grouse Gulch Mine, on a parallel vein, provided with hoisting works, but without a mill, the ore having been hauled to a custom mill; the shaft is nearly vertical, and about one hundred and fifty feet in depth; the claim is one thousand five hundred feet in length. Then lying adjoining is the Eagle King, one thousand five hundred feet in length also, and opened up by a tunnel on the ledge, seven hundred feet in length. At this juncture the Melton group of mines occur, called the Melton Mine, which is more particularly described under the proper heading. It may be said in this connection, however, that the main tunnel is located at the north end of this mining ground, and runs about four hundred and fifty feet diagonally through granite before striking the main lode, which is followed for about two thousand five hundred and fifty feet, and is still being driven. Two shafts connect with this tunnel—one, one hundred and eighty feet, and the other eighty feet deep. Parallel to the Melton veins, and an extension of one of them, is the Treat Mine, on which is a perpendicular shaft one hundred feet deep. This claim extends to the South Fork of the Cosumnes River, on the other side of which is the Mount Hope Mine, a claim of one thousand three hundred feet in length, opened by a tunnel one thousand feet in length. This property is equipped with a ten-stamp water mill, provided with free water. Two shafts—one, two hundred feet deep, and the other one hundred—afford ventilation for the Mount Hope tunnel. Next beyond the Mount Hope is the Flagstaff, with hoisting works and a ten-stamp mill. The district is well supplied with wood and water.

THE MELTON MINE.

This mine is situated in the Grizzly Flat Mining District, two and one half miles north of the town of Grizzly Flat, which lies sixteen miles due east of Placerville, but twenty-five miles distant from this town, when measured by the circuitous stage road. The course of the vein is north and south nearly, and the dip is to the west, at an angle of about 85 degrees. The average width is about three feet, and the dimensions of the claim are four thousand five hundred feet in length by six hundred feet in width.

There are said to be nine ore shoots within the boundaries of this claim, the shortest of them about fifty feet in length, and the longest three hundred and ten feet. The mine is worked by three tunnels and two shafts. The tunnels have lengths three thousand, five hundred, and three hundred feet, respectively. The lower one runs four hundred and fifty feet across country rock, and the balance of its length, three thousand feet, on the vein, attaining a vertical depth of five hundred feet from the surface. Nos. 2 and 3 are driven on the vein, and reach depths below the surface of three hundred, and one hundred feet. One of the shafts is sunk on the vein, and slightly inclines to the west, the other is perpendicular, and is connected with the vein by a twenty-foot crosscut, at the bottom, or two hundred feet from the surface. Both walls are of granite. The mine yields about one hundred and thirty-eight thousand gallons of water per day, but issuing from the main tunnel, which drains the whole mine, it affords little inconvenience in working. The National compressor, and two National drills, and one Ingersoll, are employed. About five hundred pounds of Hercules powder, No. 2, are consumed monthly. The cost of mining is estimated at $2 per ton. When running on the vein, and in favorable ground, as many as forty-five feet have been driven in a week, in the tunnels, and two feet per day in the shaft, which is four and one half by eight feet in the clear, costing $15 per foot. The tunnels are timbered, when requiring it, the timbers used being split and round spruce, costing about 5 cents per running foot; sawed lumber, costing $13 per thousand, and lagging $30 per thousand; facilities for cheap timber are unsurpassed. The company built one mile of road, and two miles of ditch, having a capacity of six hundred miner's inches of water, which is supplied free of expense. Cars transport the ore from the mine to the mill over a short tramway from the lower tunnel.

The ore is free milling gold quartz, containing sulphurets, and is crushed in a stamp mill and amalgamated in the battery and on outside plates. The mill is run by water power, applied to a four and one half-foot Knight wheel, under ninety-six feet of pressure. It consists of fifteen stamps, weighing eight hundred pounds each, dropping five inches, ninety-five times per minute, crushing one and one half tons per stamp in twenty-four hours. Iron is used for shoes and dies, and costs 6 cents per pound. A set of shoes and dies weighing three thousand one hundred and fifty pounds lasts forty days, crushing nine hundred tons. The resulting wear of shoes and dies is, therefore, three and one half pounds of iron at 6 cents per pound, or 21 cents per ton of ore crushed. No. 7 slot punched and No. 50 brass wire screens are used. Eight inches by forty-four inches are allowed for discharging surface, and the screen frames are slightly inclined.

The aprons are three by four feet in size, and the sluice, which is fifteen inches wide, is twenty-five feet in length, covered with common copper plate, inclined one and three quarters inches to one foot. The plate, inside of the battery, is six inches by forty-eight inches, and has two angles of inclination. Seventy-five per cent of the free gold is recovered in the battery, and 25 per cent on the outside plates. Blanket sluices twelve feet in length are used to each battery, and eighty feet of double riffle sluices, in which the riffles are placed every hour. The sulphurets thus obtained are still further concentrated, by means of the Cornish buddle. From 2 to 3 per cent of sulphurets are obtained, consisting of sulphurets of iron, lead, zinc, copper, antimony, and arsenic, and having a gold value of from $100 to $200 per ton. This material is freighted to the reduction works at Drytown, Amador County, at a cost of $15 per ton, and treated for $20, with a guarantee of a return of 90 per cent of the gold contents. The bullion

from this mine is said to average $13 per ounce. Ten men are employed in the mine, four men in the mill, and one on outside work. Men in the mine receive $2 50 per day, in the mill $3, and on outside work $2 50. No wood is required here in operating either the mine or mill, but the best o pine or oak can be procured at the rate of $2 per cord. The developments during the year have been confined to driving the main tunnel. The only improvements proposed are the introduction into the mill of a rock breaker, Challenge feeders, and Frue vanners. Cost of milling, per ton: Shoes and dies, 21 cents; labor, 50 cents; quicksilver and screens, 4 cents; incidentals, 10 cents; total, 85 cents.

Altitude (aneroid reading)	3,900 feet.
Length of ore shoots (nine shoots)	From 50 to 310 feet.
Length of one ore shaft on incline	200 feet at 85 degrees.
Depth of other ore shaft vertically	200 feet.
Vertical depth reached from surface by tunnel	500 feet.
Quantity of water running from the tunnel in twenty-four hours	138,000 gallons.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Kind of power used	Hercules, No. 2.
Quantity of powder used	500 pounds monthly.
Cost of mining	$2 per ton.
Cost of tunnel	$6 50 to $15 per foot.
Cost of shaft	$15 per foot.
Number of feet timbered	All.
Kind of timber	Square spruce.
Cost of timber	$13 per thousand.
Length of road built	One mile.
Length of ditch built	Two miles.
Cost of transportation of ore	11½ cents per ton.
Character of ore	Free milling, with sulphurets.
Character of works	Water power free gold mill.
Number of stamps	15
Weight of stamps	800 pounds.
Drop of stamps	5 inches.
Drops	95 per minute.
Duty of stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	Iron.
Size and character of screens	No. 7 punched, and No. 50 brass wire.
Dimensions of apron	36 by 48 inches.
Width of sluice	15 inches.
Length of sluice	25 feet.
Kind of concentrators	Blanket sluices and buddles.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	2 to 3.
Value of sulphurets	$100 to $200 per ton.
Cost of milling	85 cents per ton.
Cost of working sulphurets	(Freight, $15; treatment, $20) $35.
Percentage of value extracted from sulphurets	90 to 92.
Number of men in mill	4
Number of men in mine	10
Employed outside	1
Total number employed	15
Average wages in mine	$2 50 per day.
Average wages in mill	$3 00 per day.
Average wages paid outside work	$2 50 per day.
Cost of wood	$2 per cord.
Head of water used for power	96 feet.
Capacity of company's ditch	600 miner's inches.
Cost of water for milling and power	Free.

THE TRUE CONSOLIDATED MINING AND MILLING COMPANY.

This property is situated on the mother lode, embracing three parallel veins, four thousand feet in line, the south end being within the city limits of Placerville. The dimensions of the company's property are two thousand four hundred feet by five hundred, and one thousand six hundred feet by six hundred; the course is northerly and southerly; the dip is

easterly. The foot-wall of the west vein is black slate, associated with the usual blue gouge; the hanging-wall of the east vein is diorite (greenstone). The ore on the surface has at times been rich. There are six chimneys on the property, one six hundred feet long, with a width of from four to twenty feet; another nearly six hundred feet in length, and from one to twelve feet in width; another one hundred and fifty feet long, from two to twenty feet wide, and three others which have not been thoroughly explored. The owners of this property have constructed three quarters of a mile of road, from the main wagon road to the mine and mill, and one half a mile of ditch, and have laid nine hundred feet of pipe, giving a pressure of four hundred and fifty feet at the mill. The developments consist of a tunnel five by six and a half feet in the clear, fourteen hundred feet long, furnished with steel "T" rails. The tunnel follows a blue gouge from one foot to three and one half feet wide. The mouth of the tunnel is nearly four thousand feet northwest of Placerville. It follows a chimney of good ore for about one hundred and fifty feet, which is intact under foot, but has been stoped above. The tunnel then passes through barren ground for about one hundred feet, then encounters the apex of another chimney, which presents itself for about fifty feet. This ore is of good grade. The tunnel then runs, for about five hundred feet, without an ore body, though detached bunches of ore are of frequent occurrence. The tunnel then passes by the side of an ore body for two hundred and fifty feet; then through barren ground for about three hundred feet, to the present face, in which stringers of rich ore are making their appearance. Work is prosecuted day and night, six men being employed. The wages of miners are $2 50 per day. Hercules, No. 2, powder is employed. The tunnel sets, which are five feet apart, are of split spruce, eight by eight inches, costing 75 cents per set; cedar ties are used for the rails to rest upon; five-foot lagging costs $45 per thousand. At the mouth of the tunnel is situated a ten-stamp free gold mill, with five hundred and fifty-pound stamps. The mill is run by an eight-foot hurdy-gurdy wheel. The mill has no rock breaker, self-feeder, or concentrators, and never possessed an appliance for saving sulphurets, which are present in the rock to an extent of 1 or 2 per cent, and are of a good grade. It is proposed to supply the deficiencies of the present mill, and erect an entirely new mill as soon as the mine is more fully opened.

VAN HOOKER, GROSS, EUREKA, AND OTHER LOCATIONS.

Immediately adjoining the True Consolidated Mining Company's property on the north, lies the Van Hooker, a location one thousand feet by six hundred feet; the Gross, one thousand three hundred by six hundred feet, with two parallel leads; still further north, the Eureka, one thousand five hundred by six hundred feet, and the Brown Bear, the Cinnamon Bear, and the White Bear, each one thousand five hundred by six hundred, or eight thousand three hundred feet by six hundred feet, with parallel veins, all on the mother lode, and under the same ownership. The developments on the Van Hooker consist of an open cut and shallow tunnel one hundred feet in length, with low grade ore in sight. A lower tunnel, seven hundred feet in length, six and one half feet high, running across the foot-wall slate, attaining a depth of five or six hundred feet below the surface, and encountering water which, coming from the upper workings of the mine, drove the men from the tunnel and rendered prosecution of work almost impossible until quite recently. The Gross is opened for two or three hundred feet by little surface cuts; one shoot, worked to a depth of one hundred feet, yielded very rich ore. It is also opened by a tunnel, three

hundred feet in length, cutting both veins on the location, about sixty feet from the surface. The croppings show for about eight hundred feet. The Eureka has a shaft one hundred and fifty feet deep, now filled with water. It is stated that the mine has good ore in the bottom. A crosscut runs from the shaft, which is perpendicular, to what is said to be good ore. A tunnel runs into the parallel vein through fifty or sixty feet of ledge matter. The Brown Bear is opened by a tunnel, about sixty feet in length. Another corporation, called the Big Tunnel Company, is running a prospecting tunnel, which will cut this ground about five hundred feet below the surface, the company having simply a right of way through the mine. The Cinnamon Bear and the White Bear have only had sufficient work performed upon them to hold them. With this group of mines are eighty acres of ground for tunnels and mill sites, and so situated that all can be operated by water power under six hundred to eight hundred feet of pressure. Water can be obtained from the El Dorado Deep Gravel, Water, and Mining Company, which has an abundance of water during the entire season. Water is supplied at 20 cents per miner's inch. From twelve hundred to two thousand feet of pipe would be required, according to the locality, with which to convey water to the various locations.

CONSOLIDATION OF ROSE, CHESTER, IDA, OREGON, AND OREGON EXTENSION MINES.

These mines were located at various dates, from 1865 to 1880. Most of them are situated within the limits of the City of Placerville, and the rest just south of the city line. The course of the veins are nearly north and south, the dip is easterly, and the average width about eight feet. The combined dimensions of the claims embraced in this consolidation are five thousand feet by six hundred feet, on the mother lode. There are three ore shoots, aggregating five hundred feet in length. A tunnel, two hundred and fifty feet in length, reaches a vertical depth of one hundred and twenty feet from the surface, and an incline shaft, two hundred and twenty-five feet deep, at about 55 degrees, attains a vertical depth of about one hundred and eighty-seven feet. Both walls are slate, and the five thousand gallons of water, daily yielded by the mine, are hoisted by buckets. Hercules powder is used, and the cost of mining is about $1 50 per ton; the cost of running tunnel or drifts, about $3 50 per foot; and the cost of sinking shaft, $15 per foot. The formation passed through is slate. The mill and mine being in close connection, there is no extra cost for transportation of ore. The character of the ore is quartzose rock, associated with iron and arsenical pyrites, and galena. The ore is subjected to the ordinary free milling treatment, in the company's water power mill, which contains ten seven hundred and fifty-pound stamps, dropping eight inches, eighty-five times per minute, and crushing about one and one half tons of ore per stamp, in twenty-four hours. White iron, costing 4½ cents per pound, is used for shoes and dies, and the wear amounts to about 25 cents per ton of ore crushed. Two inches of water are used in the batteries, which are supplied with No. 40 wire screens, placed vertically. The aprons are three feet wide, the sluices one foot wide, twenty feet in length, being furnished below each apron. The plate inside of the battery is curved, and about six inches wide. The outside plates are of copper, and have an inclination of one and one half inches to one foot. The loss of quicksilver, on the average, is about 2 cents per ton of ore crushed. Four Frue concentrators are used to recover the sulphurets of iron and arsenic, existing in the rock to an extent of 1½ per cent, and containing $245 per ton in gold, and $5 per ton in silver. The sulphurets are sold to chlorination works, pay-

ing 92 per cent of the assay value. The number of men in the mine is six, in the mill two, and engaged on outside work one; the total number employed being nine. The average wages paid in the mine are \$2 75 per day, in the mill \$3 per day, and on outside work \$2 50. The mill is run by an ordinary hurdy-gurdy wheel, under two hundred and fifty feet of pressure, and requires, for power and battery, twenty-five miner's inches of water, for which a charge is made by the water company of 20 cents per inch for twenty-four hours.* Cost of milling per ton: Labor, 40 cents; water, 33 cents; quicksilver, 2 cents; screens, 2 cents; shoes and dies, 25 cents; incidentals, 18 cents; total, \$1 20.

Altitude (average of mines)	About 1,900 feet.
Length of ore shoots (three shoots)	Aggregating 500 feet.
Length of ore shaft on incline	225 feet.
Vertical depth reached in mine	187 feet.
Quantity of water raised in twenty-four hours	5,000 gallons.
Character of hanging wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Hercules.
Cost of mining	\$1 50 per ton.
Cost of tunnel	\$3 50 per foot.
Cost of shaft	\$15 per foot.
Character of ore	Free milling.
Character of works	Water power stamp mill.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamps	8 inches.
Drops	85 per minute.
Duty of stamp	1.5 tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	No. 40 wire.
Water used in battery	2 miner's inches.
Dimensions of apron	3 feet wide.
Width of sluice	12 inches.
Length of sluice	20 feet.
Kind of feeder	Challenge.
Kind of concentrators	Frue's.
Percentage of sulphurets	$1\frac{5}{10}$
Value of sulphurets	(\$245 gold, \$5 silver) \$250 per ton.
Cost of milling	\$1 20 per ton.
Number of men in mill	2
Number of men in mine	6
Number of men on outside work	1
Total number employed	9
Average wages in mine	\$2 75 per day.
Average wages in mill	\$3 00 per day.
Average wages paid outside work	\$2 50 per day.
Quantity of water used in milling	2 miner's inches.
Head of water used for power	250 feet.
Water used for power	25 inches.
Cost of water for milling and power	25 inches, at 20 cents per inch, for 24 hours, \$5.

THE PACIFIC MINE.

This mine, which is one of the oldest mines in the State, was located in 1850, and lies just beyond the southern boundary line of the City of Placerville, at an altitude of about one thousand nine hundred and twenty-five feet. The course of the vein is a little west of north, and the direction of dip is easterly, at an angle of about 68 degrees from the horizontal, and the average width is about twelve feet. The dimensions of the claim are nineteen hundred and twenty feet in length by three hundred in width; the length of ore shoot being about one hundred and fifty feet. The mine is opened by both tunnel and shaft. The tunnel, which is five hundred and fifty feet in length, strikes the vein at three hundred and twenty-five

*It is customary with this company to make rates for twelve hours or twenty-four hours.

feet, perpendicular depth. The shaft is seven hundred feet vertical. The hanging-wall is greenstone (diorite); the foot-wall hornblendic slate near the surface, but near the bottom of the mine it is black slate. The mine affords about two thousand gallons of water per day, but this comes in comparatively near the surface, very little being yielded below three hundred and twenty-five feet perpendicular, or the line of the intersection of the tunnel with the vein. Water below this point is raised by bucket. The plant was equipped with Burleigh compressor and three Ingersoll drills. In sinking the shaft Hercules powder, Nos. 1 and 2, was used. In driving the tunnel, Hercules powder and black powder were employed. The cost of mining was $2 50 per ton; driving the drifts and running the tunnel, $8 per foot; sinking the shaft, $30 per foot, including everything. About one and one half feet were sunk per day in the shaft, which in succession passes through talcose slate, hornblendic slate, vein and vein matter, and into hanging-wall greenstone or diorite. The tunnel is not timbered, but the shaft is timbered from top to bottom with solid four-inch planking, dovetailed, the cost of the material being from $18 to $20 per thousand, delivered at the mine. The distance of hauling is five miles. The company constructed and laid two thousand feet of thirty and fifteen-inch pipe, conveying the water to the mine and mill, using for this purpose Nos. 12 and 14 iron. The ore is carried from the mine to the mill by gravity, the loaded car returning the empty one. Direct communication is by a tramway six hundred feet in length, and no separate account was made for transportation of ore. The ore is the rock of the mother lode. It is stamped and amalgamated in the usual method of treating free gold ore. The tailings were concentrated with Hendy pan concentrators and Cornish buddles, blankets, and riffle sluices. At times, the concentrations recovered were treated in a barrel; at other times by pan process, and sometimes sold to chlorination works.

The mill is a water power mill, containing a Blake crusher, next to the largest size manufactured, driven by a Morey six-foot hurdy-gurdy wheel, under about two hundred and seventy-foot pressure. The main machinery driven by a Morey eight-foot hurdy-gurdy wheel, under about the same pressure. The mill grade was designed for thirty stamps, but twenty only were put in the mill. The weight of the stamps is eight hundred pounds, the drop in inches was eight, the drops per minute eighty-two, and one and one half tons were crushed in twenty-four hours. White iron, costing 5 cents per pound, was used for shoes and dies, and lasted, on the average, about forty days, indicating a wear of about four and two tenths pounds per ton of ore crushed, equivalent to about 21 cents per ton of ore. Four inches of water were used in the battery. The screens, which were arranged vertically, were No. 6 round punched, eight by forty-eight inches inside of the frame. The plates were copper, and on the apron were about thirty inches by forty-eight, and on the sluice one foot in width by sixteen feet in length, having an inclination of one and one half inches to one foot. In the batteries a front plate only was used, which was six inches in width, measured on the curve, and about forty-eight inches in length. The mill is furnished with Challenge feeders, and one combination pan and a settler. In working the concentrations four pounds of sulphuric acid and forty pounds of salt were used in the pan. The usual amount of recovery in the battery was 75 per cent, on the outside plates 10 per cent, and in pans 15 per cent. The loss of quicksilver was about 2 cents per ton of ore. The sulphurets, amounting to one half of one per cent, were arsenical pyrites of iron, containing 3 per cent nickel,* and assaying $85 per ton in gold and

*Careful examination and determination was made by Prof. Thos. Price.

$2 per ton in silver. The ore is said by reliable authority* to have milled from $6 to $18 per ton, and the tailings to have averaged from a trace in gold to 75 cents per ton, no selection being made of the ore. At the hoisting works a friction gear, with six-foot reel with flat rope, is run either by steam power or water. When running by steam a thirty-horse power engine is employed; when running by water power the water is applied to a four-foot Knight wheel, under about two hundred and forty feet of pressure. The price paid for water is 15 cents per miner's inch for twenty-four hours. Steam is only employed in case of accident to the water ditch. The developments in the mine, other than those already mentioned, consist of levels at one hundred, two hundred and forty, three hundred, four nundred, five hundred, six hundred, and seven hundred feet from the surface, each from one hundred and fifty to two hundred feet in length, and a crosscut of ten feet from the shaft to the vein at the four hundred-foot level, and others from the shaft to the vein at each succeeding level to the lowest, and a winze seventy feet deep below the seven hundred level. It is said that the ore in the bottom is as good as ever found in the mine. As this mine is idle at present, it may be pertinently asked why operations were suspended? The property was incorporated in England by a company, which issued bonds for supplying all the money, and the amount of the bonds was exhausted before the property was developed, and no more bonds could be placed. The bondholders and stockholders were largely interested in hydraulic mining, which was completely stopped by injunction, and the opinion among them became current that there was no guarantee against injunctions in case of any kind of mining. The bondholders would advance no more money on bonds which paid no interest, and were apparently wholly insecure.

Altitude (aneroid reading)	1,925 feet.
Length of ore shoot	150 feet.
Depth of ore shaft vertically	700 feet.
Vertical depth reached in mine	756 feet.
Quantity of water raised in twenty-four hours	2,000 gallons.
Character of hanging-wall	Greenstone (diorite).
Character of foot-wall	Hornblendic slate and black slate.
Kind of powder used	Hercules, Nos. 1 and 2.
Cost of mining	$2 50 per ton.
Cost of tunnel	$8 per foot.
Cost of shaft (5 by 10 feet in clear)	$30 per foot.
Number of feet timbered	All.
Kind of timber	Sawed 4-inch plank.
Cost of timber	$18 to $20 per 1,000 feet.
Character of ore	Free milling
Character of works	Water power stamp mill
Number of stamps	20
Weight of stamps	800 pounds each.
Drop of stamps	8 inches.
Drops	82 per minute.
Duty of stamp	$1\frac{5}{16}$ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	8 by 48 inches, round punched, No. 6.
Water used in battery	4 miner's inches.
Dimensions of apron	30 by 48 inches.
Width of sluice	1 foot.
Length of sluice	16 feet.
Kind of feeder	Challenge.
Kind of pans	Combination.
Number of pans	1
Kind of concentrators	Hendy Pan.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	10
Percentage of sulphurets	$\frac{1}{2}$
Value of sulphurets	$87 per ton ($85 gold, $2 silver).

* Prof. Thos. Price.

Cost of milling	75 cents per ton.
Percentage of value saved in pans	15
Quantity of water used in milling	4 miner's inches.
Head of water used for power	At hoisting works, 240 feet; at mill, 274 feet; at compressor wheel, 295 feet.
Cost of water for milling and power	15 cents per inch.

THE EPLEY CONSOLIDATED.

The Epley, Mammoth, Faraday, and Henrietta Mines, comprised in the Epley Consolidated, were located in 1867. The mines are situated about one and one half miles due south of Placerville, between Chili Ravine and Webber Creek. The course of the vein is northwesterly and southeasterly; the direction of dip is easterly, at a general angle of about 65 degrees with the horizon. The average width is about six feet. The dimensions of the four claims comprised in this consolidation are as follows: Two, one thousand two hundred feet by six hundred, and two, one thousand five hundred feet by six hundred, parallel to the first two, and twelve acres of land outside of the mining locations. There are two ore shoots on the property, one, one hundred and twenty-five feet in length, and the other one hundred and fifty feet, as far as developed. A tunnel one hundred and fifty feet in length, attaining a vertical depth of one hundred and fifty feet from the surface, an incline shaft, one hundred and twenty-five feet deep, and a vertical shaft two hundred and forty feet deep, partially open the mine. From the shaft there are three drifts, each two hundred feet in length. From the incline shaft there are two drifts, one, two hundred and twenty-five feet long, and the other one hundred and fifty feet. The walls are slate. The mine affords little water, about one thousand gallons per day, which is removed by use of a bucket. Hercules powder was employed in mining, and the cost of ore extraction was $2 per ton; the cost of running the tunnel, $4 per foot; and the cost of sinking the shaft, $25 per foot. The formation passed through was slate. Shafts and tunnel are timbered; the vertical shaft with sawed timbers, costing $20 per thousand; the incline and tunnel with round timbers, costing $1 25 per sixteen-foot length; the timber is hauled about four miles. The ore is mother lode rock, quartz and slate associated, containing iron pyrities and arsenical pyrites, with a little galena. The greater part of the gold contained in the rock is present in the free state. The method of treating the ore is battery and copper plate amalgamation, and concentration in sluices and Cornish buddles. The ore was crushed at a leased mill. The sulphurets, which amounted to $1\frac{25}{100}$ per cent of the ore, contained $175 per ton in gold and $3 10 in silver, and were sold to chlorination works. The cost of water is 20 cents per miner's inch. It is proposed to erect a twenty-stamp mill, lay two thousand feet of pipe to introduce water, to sink shafts, extend drifts, and prospect the mine generally. The Epley Consolidated was organized, but no capital was furnished by the stockholders, who were practically the same as those of the Pacific. The money for the work performed on the property was advanced by the managing agent, and was never refunded. This group of mines then naturally fell into his hands, and has since laid idle for want of sufficient capital to properly open them, though the results of limited exploration are said to have been most flattering.

Altitude (aneroid reading)	1,825 feet.
Length of ore shoot	Two shoots: one 125 feet, the other 150 feet.
Length of incline shaft	125 feet.
Depth of ore shaft vertically	240 feet.
Vertical depth reached in mine	240 feet.
Vertical depth of water shaft	240 feet.
Quantity of water raised in twenty-four hours	1,000 gallons.

Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Hercules, Nos. 1 and 2.
Cost of mining	$2 per ton.
Cost of tunnel	$4 per foot.
Cost of shaft	$25 per foot.
Number of feet timbered	All.
Kind of timber	Pine, sawed and round.
Cost of timber	Sawed, $20 per thousand; round, $1 25 per log.
Character of ore	Quartz containing iron pyrites, arsenical pyrites, with a little galena.
Percentage of sulphurets	1¼
Value of sulphurets	Gold, $175 per ton; silver, $3 per ton.
Cost of water for milling	20 cents per inch.
Cost of water for power	20 cents per inch.

THE SUPERIOR MINE.

This mine, located in 1867, is situated in the Diamond Springs District, about two and one half miles south of Placerville, and one mile east of the town of Diamond Springs. It was formerly known as the Reid Mine, and consists of three parallel leads on the mother lode, having a general course nearly north and south, and direction of dip east, at an angle of 45 degrees. The dimensions of the claim are two thousand feet in length and six hundred feet in width. An ore shoot on the foot-wall vein has been explored for about one hundred and fifty feet with pay ore in the face, the width being from two and one half to ten feet. The mine is opened by two tunnels and a shaft which is nearly vertical; the upper tunnel, two hundred and fifty feet in length, crossing the formation westerly at eighty feet from the surface, explores the shoot for fifty feet in length; the lower tunnel, following the formation in a southerly direction seven hundred feet, attains a vertical depth of one hundred and sixty feet. The pay shoot, encountered in this tunnel two hundred feet from its mouth and one hundred feet from the surface, has been explored for one hundred and fifty feet, displaying a width from two to ten feet. The shaft, situated on a line in the course of the tunnel survey, is about one hundred and eighty feet deep, measured on the incline, reaching a perpendicular depth from the surface of about one hundred and sixty feet. The hanging-wall of the east vein is a kind of greenstone, now termed diorite; the hanging-wall of the middle vein is talcose slate; of the foot-wall vein, black slate; the corresponding foot-wall rocks are talcose slate for the east vein, and black slate for the middle and west veins. About one hundred pounds of Giant, No. 2, powder are consumed monthly, and the cost of mining to the present depth is estimated at $2 per ton. The contract price for running the first one hundred feet of the tunnel was $3 30 per foot, without powder or timbers; for the balance, $2 75; about one and one half feet of progress per day being made to each man employed. The shaft, six feet ten inches by three feet ten inches in the clear, requiring an excavation of eight feet by five and one half feet, was sunk one foot per day through slate and vein matter. One half of the tunnels and all of the shafts are timbered, round and split pine being used for the former, and eight by ten-inch sawed pine for the latter; in the tunnel, posts and caps eight inches in diameter and six feet long are being employed, costing 20 cents each, sawed lumber costing $18 per thousand; all hauled from three to eight miles.

The character of the ore is free milling, like that of most quartz found on the mother lode, carrying sulphurets, and has hitherto been stamped and amalgamated in the battery and on outside plates, and concentrated in Robbins riffles. The mill, which is wet crushing, of course, has been driven by an eight by sixteen-inch donkey engine, but water is now being introduced for power, five thousand four hundred feet of pipe, eleven inches

in diameter, constructed of No. 16 iron, and one hundred and sixty feet of nine-inch pipe, conveying water to the mill under two hundred and twenty feet of head. The mill contains ten seven hundred and fifty-pound stamps, dropping five inches, ninety times per minute, crushing twenty-two tons per day. Steel shoes and dies are used at a cost of 8½ cents per pound, but no reliable data regarding their wear could be obtained, having so recently been substituted for iron. Two miner's inches of water are used inside of the battery and an additional inch is supplied to the outside plates. Nos. 40 and 50 steel wire battery screens are used, with eight by forty-eight inches of discharging surface, inclining slightly from the perpendicular. The aprons are forty-eight by thirty inches, the sluice fifteen inches wide by twenty feet long. Two plates, one in front and one in the back of the mortar, are used, forty-eight by eight inches in size. The plates inside and out are of copper, those on the outside inclining one and one half inches to one foot. About 80 per cent of free gold value is recovered in the battery and 20 per cent on the outside plates. The last one hundred tons worked produced 5 per cent of concentrations, consisting mainly of iron pyrites, having a value of $130 per ton, and were saved in Robbins riffles, sixty-five feet in length, two sets being employed, each used alternately. The sulphurets have been shipped for reduction. Seventeen men are employed, including the foreman—ten in the mine, six in the mill, and one on outside work. The wages paid, per day, are $2 50 in the mine, $3 in the mill, and $3 for a carpenter engaged on outside work. Three to four cords of thirty-inch pine wood, costing $2 75 per cord, are consumed per day.

The development on the mine, besides the tunnels and shaft, is a winze sunk sixty feet, measured on the incline, below the lower level; stopes, in working order, are opened one hundred and fifty feet in length, between the two levels. During the past year the shaft was sunk seventy-eight feet, and the tunnel driven three hundred feet, and the winze excavated, and three crosscuts were made; one driven thirty feet west, one twenty feet east, and another fourteen feet west, and stopes opened. It is intended to immediately erect water power works, capable of sinking five hundred feet, and, in order to carry the water to the Pelton wheel which will drive the works, three hundred and thirty feet of seven-inch pipe, connecting with the main, has already been laid. The mill will be equipped with Pelton wheels, Challenge feeders, rock breakers, and Frue vanners.

The yield of the mine has been, according to the company's report, $15 per ton in free gold, above the upper level, no sulphurets having been saved; between the two levels, one hundred and thirty-five tons yielded $783 50, or $5 80 per ton, and one hundred and forty-seven tons yielded $1,813 44, or $12 33 per ton. The means of saving sulphurets having been incomplete, the company has hitherto suffered a considerable loss in consequence, which it is expected to avoid by the introduction of Frue concentrators.

Altitude (aneroid reading)	830 feet.
Length of ore shoot	150+ feet.
Length of ore shaft on incline	180 feet.
Vertical depth reached in mine	205 feet.
Character of hanging wall	East vein, diorite (greenstone); middle vein, talcose slate; foot-wall vein, black slate.
Character of foot-wall	East vein, talcose slate; middle vein, black slate; foot-wall vein, black slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used	100 pounds monthly.
Cost of mining	$2 per ton.
Cost of tunnel, without powder or timbers	$2 75 to $3 30 per foot.
Number of feet timbered	180
Kind of timber	Sawed pine.

Cost of timber	\$18 per thousand.
Length of road built	$\frac{1}{4}$ mile.
Character of ore	Free milling, with sulphurets.
Character of works	Wet crushing gold mill.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamps	5 inches.
Drops	90 per minute.
Duty of stamp	$2\frac{3}{10}$ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Steel wire. Nos. 40 and 50.
Water used in battery	2 miner's inches.
Dimensions of apron	48 by 30 inches.
Width of sluice	15 inches.
Length of sluice	20 feet.
Percentage of gold saved in battery	80
Percentage of gold saved on plates	20
Percentage of sulphurets	1 to 5
Value of sulphurets	\$130 per ton.
Number of men in mill	6
Number of men in mine	10
Number of men on outside work	1
Total number employed	17
Average wages in mine	\$2 50 per day.
Average wages in mill	\$3 per day.
Wood used (30 inches in length)	3 to 4 cords per day.
Cost of wood	\$2 75 per cord.
Quantity of water used in milling (estimated)	2 to 3 miner's inches.
Cost of water for milling	15 cents per miner's inch.

MILLER MINE.

Adjoining the Superior Mine on the north is situated the Miller Mine, developed by two shafts, each thirty-five feet in depth, and one shaft eleven feet deep, and one tunnel one hundred and twenty-five feet in length, attaining a vertical depth of thirty-five feet. The ore, running from two to four feet in thickness, appears to contain a good percentage of sulphurets. The Parlow ground consists of parallel claims west of the Superior.

GRIFFITH CONSOLIDATED MINING COMPANY.

This mine is situated on the mother lode belt, and has the usual course, a little west of north. The dimensions of the claim are six hundred feet in width by three thousand feet in length. The mine is opened by a shaft one hundred and fifty feet deep. The company has a five-stamp free gold mill, run by water power, in connection with the mine. The stamps weigh four hundred pounds each. This property lies about one and one quarter miles east of Diamond Springs, at an altitude of about eighteen hundred and fifty feet, by aneroid reading.

THE MANZANITA QUEEN.

This property is an extension of the Griffith Consolidated Company's mine. The claim is six hundred feet in width, and fifteen hundred feet in length, and embraces three parallel veins of the mother lode. A tunnel two hundred and thirty feet in length is being driven, to cut the ledges at right angles, at a depth of one hundred and fifty feet.

THE ORIFLAMME.

This mine is situated one mile southeast of Diamond Springs. The ore shoot is in the contact between the diorite, on the hanging-wall side, and the black slate, on the foot-wall side. It is being opened by a tunnel two

hundred and forty feet long, and a shaft forty feet deep. Present exploration indicates a chimney about two hundred feet in length, and from one to ten feet in width. It is proposed to sink a two-compartment shaft, five and one half by ten feet in the clear. This location, made in 1880, is on the mother lode.

EQUATOR MINING COMPANY.

North of the Church Mine, in the Mud Springs Mining District, the Equator Mining Company owns twenty-nine locations and an agricultural patent to one hundred and seventy-two acres, all situated in the Diamond Springs Mining District, about two and one half miles southeast of the town of Diamond Springs, and about three miles southeast of El Dorado. The company's claims are situated on the belt of the mother lode, and consist of three parallel veins on the western side, aggregating eighteen hundred feet in width and three thousand feet in length, and on the eastern side twenty-six parallel locations, comprising three thousand feet in width by fifteen hundred feet in length. The course of the veins conforms to the general trend of the mother lode in this locality—a little west of north and south of east, with an easterly dip. The veins are mostly in black slate, and the diorite (greenstone) and black gouge are in the usual occurrence. The shoots have not all been explored. One is over two hundred and fifty feet long on the surface, showing a width of about three feet. There is one incline, one hundred and ten feet deep, and at the bottom is a drift in ore two hundred and fifty feet long. There are three other inclines, from ten to seventy-two feet deep, and two tunnels, running east and west, three hundred and five hundred feet, respectively, situated near the bed of Mathines Creek, which passes through the property at an altitude of about twelve hundred and fifty feet, as indicated by the aneroid. A substantial building midway between the tunnel mouths incloses an Ingersoll compressor and a four-foot Pelton wheel, which drives, under one hundred and fifty-foot pressure, two Ingersoll drilling machines at the face of each tunnel. Sixty-five miner's inches of water are required for this power. The water is free, however, for seven months in the year, the company having, at an expense of $800, constructed about one hundred and eighty-eight rods of ditch, capable of conveying a volume of two hundred and fifty miner's inches of water. If it were required, water can be obtained by making proper connections with the Park Canal, affording a head at this point of about four hundred and fifty feet. Both tunnels are furnished throughout with twelve-pound "T" rails. Five hundred to seven hundred and fifty pounds of Safety Nitro powder, No. 2, are used monthly. Very little timber is required, but it can be obtained for $20 per thousand. It is proposed to put up a twenty-stamp mill on the property.

MATHINES CREEK MINE.

About two and one half miles due north of the Church Mine is situated the Mathines Creek Mine, on which a five-stamp Huntington mill is in operation, crushing nine to ten tons of ore per day, using a No. 9 angle slot screen. The mill is run by a three-foot Knights wheel, under seventy-foot pressure, requiring forty-five miner's inches of water at a cost of 20 cents per inch. The mill is provided with an outside electroplate, two and one half by five feet in dimensions. The rock is said to contain about 3 per cent of sulphurets, but only thirty pounds per day are recovered, burlap being used for this purpose. The mine is worked by tunnels, one, one hundred feet in length, the other, three hundred; the walls are slate.

THE CHURCH MINE.

This mine adjoins on the north the old Springfield or Church Union Mine, which was worked to a perpendicular depth of sixteen hundred feet. It is situated in the Mud Springs Mining District, three miles southeast of the town of El Dorado, formerly known as Mud Springs. It lies on the mother lode, and the vein at this point has a course of about 15 degrees west of north, and the dip on the surface was westerly about 80 degrees for one hundred and fifty feet in depth. For the last one hundred and fifty feet the dip has, however, been easterly, at about an angle of 80 degrees with the horizon. The ore shoot is lenticular in shape, and has a width of fourteen feet, in its widest place, and a length of about seventy-five feet. There is another shoot that has not been explored. The dimensions of the claim are fifteen hundred by six hundred feet. The mine is opened by a tunnel two hundred and forty feet in length, reaching a vertical depth from the surface of eighty feet, at one hundred and forty feet from the mouth. It is connected with the surface by a shaft sixty-five feet deep. The mine is worked principally through a shaft three hundred and fifteen feet deep, and practically vertical. The hanging and foot-walls of the vein are black slate. The mine yields about twenty thousand gallons of water per day. The water is raised from the three hundred level to the two hundred, by a four-inch plunger pump; from the two hundred to the surface by a six-inch Cornish jackhead pump. The Richmann upright duplex compressor, and Richmann drills are used. Six hundred pounds of Safety Nitro, No. 2, powder are consumed monthly; and about one hundred pounds of three-quarter-inch Firth & Sons steel. The cost of mining is about $2 per ton. The surface tunnel, which required no timber, was driven for about $2 50 per foot. The work was done with single hand drills, and two to three feet of progress were made in twenty-four hours. The drift on the one hundred-foot level cost, including timbers, $3 50 per foot. The cost of sinking the shaft per foot, by last contract, was $12 50 for the labor, candles, powder, etc.; the timbers being extra. The size of the shaft, which is sunk through vein matter, is four by seven feet in the clear, timbered with eight by eight-inch spruce timbers. Sinking progressed at the rate of one and one half feet per day. Sawed lumber is delivered at a charge of $18 50 per thousand; round timbers, sixteen inches in diameter at the smaller end and fourteen feet long, are delivered for $2 25 each, and five-foot lagging for $75 per thousand. All timber has to be hauled about twenty-five miles.

The company built about one half mile of road and laid two thousand four hundred and fifty feet of eleven-inch pipe, constructed of No. 12 iron. The mine and mill being close together, there is no expense for transportation of ore, except the amount paid for carman, $2 per day, which represents about 12½ cents per ton. The ore is the ordinary rock of the mother lode, free milling gold ore, containing a little sulphurets. It is wet crushed in a stamp mill, amalgamated in the battery, and on outside plates. The mill is driven by a six-foot Pelton wheel, to which water, under four hundred and seventy-five-foot pressure, is applied through a three fourths-inch nozzle. The mill contains a rock breaker, ten stamps, weighing eight hundred and fifty pounds each, dropping six inches, eighty-five to ninety times per minute, crushing sixteen and one half tons in twenty-four hours, including ordinary stoppages. The shoes and dies are of iron, from the Placerville foundry, and cost 6 cents per pound, delivered. A set of these shoes weigh one thousand two hundred and fifty pounds, and the dies one thousand pounds, and last thirty-five days; consequently the wear is three

and nine tenths pounds of iron to a ton of ore crushed, equivalent to 23½ cents, at this price for iron. About four inches of water* are used in the batteries, with what is required for the concentrators. Tinned iron, round punched, No. 0, corresponding to No. 40 mesh wire, is used for screens for the battery, and last, on the average, one week. The screens are slightly inclined from the perpendicular, and have a discharging surface of eight inches by forty-eight inches. The aprons are four by four feet, the width of the sluice fourteen inches, and the length is twelve feet to each battery. The inside plates, which are eight inches by forty-eight inches, are slightly convex on the coating surface, and are of copper, while electroplates are used on the aprons and sluices, having a grade of one and three fourths inches to the foot. Templeton or roller feeders are used. About 80 per cent of the recovery in free gold is made in the battery, and 20 per cent on the outside plates. Four thousand pounds of concentrations are recovered monthly. The loss of quicksilver has been less than two flasks in nearly two years' milling, or approximately nine tenths of a cent per ton. The mill is furnished with two Frue concentrators. About four tenths of one per cent of iron sulphurets are recovered and sold to Selby's Works at Vallejo Junction, at a cost of about $25 per ton for freight and treatment.

There are sixteen men employed in the mine, including the foreman, four men in the mill, and five on outside work, or a total of twenty-one men. In the mine the average wages are $2 50 per day; in the mill $3, on outside work $2 to $3. One half a cord of pine wood, costing $4 50 per cord, is used for steam purposes. The pump is run by four inches of water applied to a six-foot Pelton wheel, designed for the compressor; the water driving the wheel is afterwards utilized in the battery and on the concentrators. The water costs 20 cents per inch. At the hoisting works steam is used altogether. The boiler is an upright and the engine has an eight-inch cylinder and a twelve-inch stroke. At each one hundred feet from the surface a level is driven. At one hundred feet the drift north is forty-eight feet, and south one hundred and sixty. A cross drift from the shaft to the ledge is seventeen feet in length. At the two hundred-foot level the crosscut to the ledge is thirty-two feet, and the north drift sixty-eight feet, and the south drift sixteen. At the three hundred-foot level the crosscut to the ledge is thirteen feet in length, and the drifts are progressing north and south. All developments from the two hundred-foot level down to the present depth have been made during the past year, as well as some on the two hundred-foot level. A winze, being sunk to the three hundred level, has attained a depth of sixty-five feet. It is proposed to put ten stamps more in the mill and equip it with Challenge feeders, and two Frue vanners to each five stamps. It is also intended to introduce water power machinery at the hoisting works and sink a three-compartment shaft, six by sixteen feet in the clear.

The expense of milling: Labor, 73 cents; shoes and dies, 24 cents; water, 17 cents; quicksilver, screens, oil, and lights, 3 cents. Total, $1 17.

Altitude (aneroid reading)	1,200 feet.
Length of ore shoot	Two shoots: One 75 feet, other not explored.
Length of ore shaft on incline (practically vertical)	315 feet.
Depth of ore shaft vertically	315 feet.
Vertical depth reached in mine	315 feet.
Quantity of water raised in twenty-four hours	20,000 gallons.
Character of hanging-wall	Black slate.
Character of foot-wall	Black slate.
Kind of powder used	Safety Nitro, No. 2.
Quantity of powder used	600 pounds.

* The measurement of water allowed by the Park Canal Company, from which this water is purchased, is five inches above the top of a two-inch slot in an inch plank.

Cost of mining	$2 per ton.
Cost of tunnel	$2 50 to $3 50 per foot.
Cost of shaft (labor, powder, and tools)	$12 50 per foot.
Number of feet timbered	All.
Kind of timber	Square spruce.
Cost of timber	$18 50 per 1,000 feet.
Length of road built	½ mile.
Cost of transport of ore	12½ cents.
Character of ore	Free milling.
Character of works	Water power stamp mill.
Number of stamps	10
Weight of stamps	850 pounds.
Drop of stamps	6 inches.
Drops	85 to 90 per minute.
Duty of stamp	1$\frac{9}{10}$ tons in twenty-four hours.
Kind of shoes and dies	Iron.
Size and character of screens	Tin: No. 1, round punched (corresponding to No. 40 wire).
Water used in battery	4 inches.
Dimensions of apron	4 by 4 feet.
Width of sluice	14 inches.
Length of sluice	12 feet.
Kind of feeder	Roller or Templeton.
Kind of concentrators	Frue.
Percentage of gold saved in battery	80
Percentage of gold saved on plates	20
Percentage of sulphurets saved	$\frac{4}{10}$
Value of sulphurets	$200 per ton.
Cost of milling	$1 17 per ton.
Cost of working sulphurets	$20 per ton and freight.
Number of men in mill	4
Number of men in mine	16
Number of men employed on outside work	5
Total number employed	25
Average wages in mine	$2 50 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2, $3, $3 50 per day.
Wood used	½ cord per day.
Cost of wood	$4 50 per cord.
Quantity of water used in milling	4 miner's inches.
Head of water used for power	475 feet.
Water used for power	18 miner's inches.
Cost of water for milling	Free.
Cost of water for power	Mill, 14 inches at 20 cents, $2 80; pump, 4 inches at 20 cents, 80 cents.

THE EL DORADO GOLD MINING AND MILLING COMPANY—THE SHAW MINE.

This mine is situated in the Mud Springs District, about three miles northwest of the town of El Dorado, at an altitude of about sixteen hundred and fifty feet. The course is a little west of north, magnetic, and the dip is easterly. The size of the claim is one thousand five hundred by six hundred feet; the shoots are not regular in length or width. The mine is worked by two tunnels and two shafts; the north tunnel, on the course of the vein, has a length of about one hundred feet; the east tunnel, more properly a crosscut through vein matter, has a length of about one hundred feet, also. One of the shafts is an incline about thirty-five feet deep, the other a perpendicular, about forty feet deep. The shafts are timbered with sawed pine, costing $18 per thousand. The company constructed about a mile of road, repaired the ditch, and laid several hundred feet of seven-inch pipe, conveying water to the mine and Huntington five-foot mill. The expense of water is 12½ cents per miner's inch. The mill is furnished with a Nichols pulverizer and Hendy feeder. The number of men in the mine is variable; in the mill, four men and a foreman. The average wages paid in the mine are $2 50 per day; in the mill, $3. A twelve-horse power engine is used at the perpendicular shaft, and about a cord of pine wood, costing $2 75 per cord, is consumed.

GRAND VICTORY MINE.

This mine is situated about four miles east of Diamond Springs. The walls are slate, and the shoot is about forty or fifty feet wide in some places; the general trend being northeast and southwest, and the dip easterly. The mine is worked principally by tunnel and open cuts, vertically about two hundred feet below the surface; very little timber was used in working the mine. The company has, in connection with the mine, a forty-stamp mill, run by a "Leffel" turbine, under about one hundred feet head, or, in case of failure of water power, by steam. The ore is very peculiar, containing very little quartz, properly so called, but a great deal of siliceous material, very hard at times, and seemingly porphyritic in its nature, carrying a large percentage of iron sulphurets, containing antimony, arsenic, etc. The mill is supplied with two rock breakers, Challenge feeders, and eight hundred-pound stamps; and wire screens were used, Nos. 40, 50, and 60. Connected with the mill is a reverberatory furnace, some sixty or seventy feet in length, used for roasting the sulphurets recovered. Different methods have been in use for working the ore; at one time amalgamation in the batteries and on outside plates, and concentration on Frue vanners; at another, concentration on canvas sluices, and recovery of gold by barrel process. Wood is $3 50 to $4 per cord; lumber, $16 per thousand. The ore appears to be rebellious, and considerable loss has occurred, it is stated, in working the ore by whatever process was adopted.

SHARP AND BOYER MINE.

This mine is situated about six miles east of Placerville, at an altitude of about two thousand three hundred feet, by aneroid reading. It has been located for about nineteen years. The vein has a northwest and southeast course and easterly dip, at an angle with the horizon varying from 20 to 70 degrees. The distance from the hanging-wall to the foot-wall is about twelve feet, the foot-wall being granite and the hanging-wall slate. Between these walls there are two ore strata, from one to two feet in width, with vein matter between them. The developments consist of a shaft, three by five feet in the clear, fifty-four feet deep, and two tunnels; one, one hundred and ten feet, and the other, one hundred and eight feet long. It is proposed to bring in water, sink a new shaft, and erect a ten-stamp mill in the near future.

CHILI RAVINE MINE.

This mine, situated in the Chili Ravine District, about two miles south of Placerville, was located eighteen years ago, and consists of seventy-six acres, secured by United States mineral patent. The gravel covering the entire claim is more or less auriferous, but richer in some channels than in others. The mine is worked through two tunnels—a cross tunnel twelve hundred feet in length, running east and west, and another seven hundred feet in length, nearly forty feet lower, running north and south, with the course of the lead. Natural ventilation is secured by three circular air shafts, three and one half feet in diameter, the deepest of them being one hundred and twenty-five feet, and the others seventy and eighty feet deep, respectively. The cost of running the tunnels was $1 50 per foot, by contract, including powder. The shafts, passing through mountain gravel and yellowish beds of lava, are more expensive than tunnels to excavate. The gravel is firmly cemented, and yields only a small portion of its gold contents, unless disintegrated by wet crushing. The bedrock, which under-

lies from three to twelve feet of the better portion of the gold-bearing gravel, is slate, associated with diorite, and occurs in benches, occupying different levels along the course of the lead. The yield of a carload, roughly estimated at fifteen hundred pounds, is about $1 75 per ton; the average number of carloads daily extracted by the miner, depending, of course, on the nature of the ground and the thickness of the "face;" six carloads being a common day's work for one man. The pay channel is sometimes one hundred feet in width, sometimes but fifty, running wide and narrow like a modern river. Split spruce timber, eight by ten inches and six feet long, costing 12 cents per running foot, is used, the distance of hauling being eight miles, but all the way on a down grade to the mine. In the tunnels a set, consisting of two six-foot posts and a four-foot cap, is arranged every four feet. Some lagging is required, costing $60 per thousand, but the shafts, being round, stand well without timber. There is not sufficient water in the mine to cause inconvenience, under this system of working, the amount being about ten thousand gallons per day discharged from the tunnels. The bowlders encountered, however, many of which are of large size, some weighing three or four tons, are in some places very numerous. Where the pay is best, the bowlders are said to be the largest and most plentiful, and nearly all smooth, round quartz. On an average, eighteen men are employed, at $2 50 per day. The gold is said to average $19 per ounce, and the monthly gross production to be about $3,000. The gravel is crushed in a ten-stamp water power mill; each stamp, weighing five hundred and fifty pounds, drops five inches eighty-five times per minute; the shoes and dies are of Brooklyn chrome steel, costing about 8 cents per pound, and lasting six months. Screens, with one quarter-inch mesh, are used, and with a two-inch discharge above the die, allow from eighty to one hundred carloads of crushed material to pass from the battery every twenty-four hours. Quicksilver is introduced into the batteries, and the amalgam is caught in the batteries, on outside plates, and in riffle sluices. The water, which gives a pressure at the mill of about one hundred and fifty pounds to the square inch, is conveyed through one thousand seven hundred feet of pipe. Ten miner's inches are required for power and use in the batteries every twelve hours, at an expense of 15 cents per inch. Though the mine has been working more or less for eighteen years, the mill has only been erected a little over a year. It is a representative of the mines in Chili Ravine, though some have more water to contend with on account of working through incline shafts, hence requiring pumps. Under this circumstance, Cornish jackhead four to seven-inch pumps are used.

Altitude (aneroid reading)	1,890 feet.
Course of lead	Northerly and southerly.
Length of tunnels	1,200 and 700 feet.
Depth of shafts	125, 80, and 70 feet, respectively.
Cost of tunnel	$1 50 per foot.
Cost of shaft	$1 50 per foot.
Nature of pay gravel	Cemented blue gravel.
Nature of bedrock	Slate and other rock.
Depth of gravel drifted	From 3 to 12 feet.
Pay	$1 75 per car.
Length of time worked	About one year with a mill.
Timbered or not	Timbered.
Many bowlders or not	Very many.
Number of men worked	18
Wages	$2 50 per day
Gross product	$3,000 monthly.

Adjoining the Chili Ravine Mine, and situated in Sec. 20, T. 10 N., R. 11 E., M. D. M., there is situated a gravel property, on which little

prospecting has been done; on it is a tunnel, from which, it is said, in early days, about $35,000 were taken.

THE LINDEN GRAVEL MINE.

The Linden Gravel Mine is situated in the Cedar Hill District, one and one half miles southeast of Placerville, and consists of about one hundred and twenty acres of mineral land, over all of which the gravel is spread, but having a general course of northwest and southeast. The developments consist of one main tunnel, three thousand feet in length, with branches and two uprises to the surface, for purpose of ventilation, one sixty and the other one hundred and sixty feet in height. The tunnel cost $2 50 per foot, by contract, for labor, the company furnishing powder, tools, and timber; the uprises cost from $1 50 to $2 50 per foot, and were made through slate, cement, and lava. The gravel is cemented, and four feet to four and one half are drifted. Cars holding two thousand pounds are used, but on account of the recent date at which operations recommenced, it is impossible to determine accurately either the pay per carload, or the number of carloads mined to the number of men employed, but a calculation has been made to handle about four carloads per man for the total number engaged in the mine and mill; all of the gravel is crushed. The average width of the pay gravel has not been determined; it has been ascertained to be from fifty to five hundred feet wide; in the mine adjoining, formerly worked, the width of the channel is said to have been five hundred feet. In some places the ground is exceedingly heavy, and a great deal of timbering is necessary; round timber, twelve to eighteen inches in diameter, are used in the tunnel, and split spruce timbers about eight inches square are used in breasting in some parts of the mine. The sets of timber are placed four feet apart, and cost 75 cents per set for the heaviest split timbers, 40 cents for the lightest, and $1 per set for the round. Considerable water is present in the mine, but it causes little inconvenience, as the tunnel furnishes an excellent mode of drainage. The pay gravel contains a large amount of quartz bowlders. Twenty-five to thirty men are employed at $2 50 per day. The developments, other than the tunnel and uprises, consists of about one thousand feet of cross drifts. About twenty-five pounds of Safety Nitro powder, No. 1, and the same amount of No. 2 are consumed monthly in extracting sufficient gravel to supply the requirements of the company's ten-stamp mill. Water, with a head of two hundred feet, is the motive power of the mill, which requires ten miner's inches per day, applied to a Pelton wheel, so situated that seven inches of water required for power may be subsequently used in the battery.

The stamps weigh five hundred and fifty pounds each. The mortars, which discharge on both sides, are supplied with wire screens having a quarter-inch mesh; the width of the mortars is about fifteen inches; the height of discharge is about five inches, and the stamps, which have a drop from five to seven inches, fall ninety-five times per minute, crushing about ninety tons in twenty-four hours. The batteries are fed by hand. Water is supplied at a charge of 30 cents per miner's inch for twenty-four hours. The three men in the mill work eight hours each. Quicksilver is used in the battery, where a small portion of the amalgam is recovered; more amalgam is obtained from quicksilver riffles and copper plates, which are used on the aprons, having a drop of two and one half inches to one foot. Most of the amalgam is obtained, however, from riffle sluices, the first sixty feet of which are made by inserting in an ordinary sluice a false bottom of one

and one half-inch plank, in which one and one half-inch holes have been bored and arranged in twos and threes across the plank. Below this sluice thus arranged, one of another construction has been found more effective as a gold-saving appliance; in the bottom of a sluice three scantlings, two by three inches in dimensions, in which one and one half-inch holes have been bored every twelve inches, are laid flatwise, and cleats, made to reach one half inch above the scantling, are placed crosswise, between each set of holes. By means of these mechanical devices, in combination as described, the greater part of the value of the cemented gravel is supposed to be recovered.

Altitude (aneroid reading)	1,950 feet.
Course of lead	Northwest and southeast.
Length of tunnel	3,000 feet.
Depth of shafts	60 and 160 feet.
Cost of tunnel	$2 50 per foot for labor.
Cost of shaft	$1 50 and $2 50 per foot.
Nature of pay gravel	Cement.
Nature of bedrock	Slate and granite.
Depth of gravel drifted	4 to 4½ feet.
Length of time worked	25 years on and off.
Timbered or not	Timbered.
Many bowlders or not	Many.
Number of men worked	25 to 30.
Wages	$2 50 per day.

THE ROGERS GRAVEL MINE.

This mine is situated in Smith's Flat District, three miles east of Placerville, and comprises a little over one hundred acres of gravel. The general course of the deep channel is north and south, but it is very crooked. There are various benches of gravel lying in other directions. The mine is worked through an incline shaft, having an angle of 30 degrees with the horizon, and a depth of seven hundred and fifty feet. The shaft, which stands inclined to a line running south 51 degrees east, has two compartments, and is six by seven feet, inside measurement, and is nearly all timbered with spruce, and passes through lava and cement strata to the bedrock, which is mostly slate, though sometimes granite on the east side of the channel. The pay gravel drifted sometimes attains a thickness of twelve feet; sometimes is but one foot in thickness, but usually is from four and one half to five feet. The cars have an average capacity of one thousand pounds, and from $1 to $4 is considered the average pay per carload, and five are expected per day to each man, when everything is running under favorable circumstances. Disintegration of the cement necessary to economically recover the gold is effected by wet crushing. The width of the pay channel is from fifty to one hundred and twenty feet wide; but besides this main channel there are three side benches, two on the west and one on the east. One on the west side is seventeen feet above the channel, and the other forty feet, and have a southerly dip of about one foot in one hundred feet, like the main channel, the side benches appearing to have been a part of the original gravel wash from which the main channel derived material. A great deal of timbering is necessary. Round timber, from six to fourteen inches in diameter, is usually employed, and is purchased at a cost of 1 cent per foot for each inch of diameter at the smaller end. There is some timber about the mine, but the most of it is hauled about six miles. There is not a great deal of water to contend with, comparatively speaking. A Cornish lift pump, with eight-inch column, making five four-foot strokes per minute, is kept running continu-

ously. Five miner's inches* of water, acting on an overshot wheel, forty-four feet in diameter, with twenty-inch breast, are required to do this work. The charge for water is 20 cents per miner's inch. About twenty-four men are employed in the mine, at the rate of $2 50 per day, and two in the mill, at $3 50. The gross production is stated to be $3,500 per month. Besides the main shaft there is another incline on the mine, five and one half feet square in the clear, having an inclination toward the east 52½ degrees with the horizon, and one hundred and seventy feet deep, and there are about four thousand feet of underground drifts. The hoisting works are what is termed the Morey friction gear hoist, and grass rope, one inch in diameter, is used, and lasts about three months, hoisting an average load of about twelve hundred pounds. The rope weighs about seven tenths of a pound per foot, and costs 3½ cents per pound.

The gravel is crushed in a ten-stamp mill, with double discharging mortars, and five hundred-pound stamps, dropping six inches, ninety-six times per minute. The width of the mortars is sixteen inches, and the height of discharge, when new dies are put in, is three inches, and the screens used are one sixteenth-inch square mesh. About one hundred and thirty tons of gravel are crushed per day. Steel shoes and dies are used, costing 8½ cents per pound in San Francisco. The present set have crushed sixteen thousand carloads of gravel, and are still smooth, and about three inches of the original eight of the shoe remain. No rock breaker is used, and feeding is done by hand. The mill is driven by a Knight four-foot wheel, under sixty feet of pressure. About thirty-five miner's inches of water are required to drive the mill, and six inches are used in the batteries, every twenty-four hours. When the mine and mill are running, seventy-five inches of water are required per day, at a cost of $15. When the mill is not running, the cost of water per day for the hoisting works and pump is $10. The gold is recovered on outside plates, in quicksilver riffles, and sluices. The size of the apron is forty-eight by fifty-two inches, and the grade is six inches in forty-eight, and they are arranged with three riffles, each two inches deep and three inches wide, in the upper one of which thirty pounds of quicksilver are placed at the commencement of the run. Below the aprons are sluices, twelve inches wide and one hundred and fifty feet long. Three feet of the sluices, next to the aprons, are furnished with Hungarian riffles, one and one half inches deep and two inches wide. The rest of the sluices are provided with false bottoms, bored with one and one half-inch holes, eight to each square foot, two and three alternating across the bottom.

Altitude (aneroid reading)	2,300 feet.
Course of lead	North and south.
Depth of shaft	750 feet.
Nature of pay gravel	Cemented, some blue gravel.
Nature of bedrock	Principally slate, some granite on east side.
Depth of gravel drifted	From 1 to 12 feet; usually 4 to 5 feet.
Pay	$1 to $4 per car (1,000 pounds capacity).
Length of time worked	On and off since 1871.
Timbered or not	Timbered.
Many bowlders or not	Many.
Powder used	250 pounds Giant, No. 2, per annum.
Number of men worked	26
Wages in mine	$2 50 per day.
Wages in mill	$3 50 per day.
Gross monthly product	$3,500

* The water measurement applied is a head four inches above the top of a two-inch slot in a two-inch plank, Amador measure.

THE EL DORADO WATER AND DEEP GRAVEL MINING COMPANY.

This company, having a principal place of business at Placerville, and main office in San Francisco, derives a water supply from the South Fork of the American River, and in the dry season from Echo Lake, in this county, and from Silver Lake, in Amador County. The main line of the company's canal is forty-five miles in length, with a capacity of ten thousand miner's inches. The flumes are six by eight feet; there are one hundred and fifty miles of branches; the total cost, $1,250,000. The charge for water is 20 cents per miner's inch, which is measured by a pressure of five inches above the top of a two-inch slot, through an inch plank; fifty cubic feet for twenty-four hours being considered by the company to be a miner's inch. The canal starts at Cedar Rock and runs to the Blakeley reservoir, thence distributes to Placerville, White Rock reservoir, and Corn Hollow. The Placerville branch has a capacity of two thousand to three thousand miner's inches, giving a pressure at the Pacific Mine of two hundred and ten feet, and a pressure of two hundred and seventy feet at the Pacific Mill.

THE PARK CANAL COMPANY.

This company derives its water supply from the extreme South Fork of the American River, and from Camp and Park Creeks.

THE CALIFORNIA WATER COMPANY.

This company obtains water principally from Loon Lake and its tributaries.

SLATE QUARRIES.

There are three or four slate quarries opened in the vicinity of Placerville. The quality and color of the slate is unexceptionable.

THE LANDEKER QUARRY.

This quarry is situated four miles northwest of Placerville, near the town of Kelsey. It has been opened for years, and several carloads have been shipped. The color is dark blue or black. A building in Placerville has been roofed with the material for the last twelve years, the slate giving entire satisfaction as roofing.

THE CHILI BAR SLATE QUARRY.

This quarry is situated two and one half miles northwest of Placerville, on the south bank of the American River. It was opened September, 1887. It is said that there is no better or tougher slate in the United States. This company employs from eight to sixteen men, and has secured water power for machinery for sawing and planing, and intend to get out and furnish slate for mantels, blackboards, billiard table tops, etc. The slate is prepared in the following thicknesses: one-sixteenth, three thirty-seconds, and one-eighth inch; the lengths are usually double the widths, as six inches by twelve inches, seven inches by fourteen inches, eight inches by sixteen inches, nine inches by eighteen inches, ten inches by twenty inches, though some sizes are six inches by fourteen inches, ten inches by eighteen inches, nine inches by twenty inches, and twelve inches by twenty-two inches. Ten feet square constitute one "square;" thirty squares aver-

age ten tons in weight; forty-five squares, or fifteen tons, make a carload, on which the freight is $40 per ton to San Francisco. The slates are sold at $7 50 per square. The slate, after being quarried, is kept moist with water, and is split by hand, blocks from four to six inches thick being split with chisels, each piece being separated in the middle and each subdivision again split in the same way, until the requisite thinness is acquired; it is then, by large shears, worked by the foot, cut into desired sizes. As an illustration of the toughness of these slates, it may be said in this connection that the letters composing the name of this company were hammered out of the slate with a common hammer, and nailed on the principal building as a sign. Orders have been received for more slate than can be manufactured for months.

THE BUCK QUARRY.

This quarry adjoins the "Chili Bar," and affords employment for about sixteen men. Remarks and description of one quarry and the process of preparation of slate will apply to the others. This slate is the west country rock of the mother lode, in a locality where its character and occurrence are favorable for the use to which it is applied.

MISCELLANEOUS.

Soapstone of fine quality is said to occur about two miles from the railroad depot in Placerville, and asbestos is plentiful in different localities. A deposit of electro-silicon occurs one and one half miles east of Placerville; it is owned by a Boston company. A fine variegated marble is found twelve miles northeast of Placerville. Granite and lava for building stone is plentiful a few miles east of Placerville. A lava, resisting an ordinary fire very well, and making a desirable building stone, is found at Diamond Springs. At Newtown, nine miles southeast of Placerville, the so called "landscape rock" occurs; the tree-like markings are due to oxide of manganese. A fine-grained white siliceous rock, resembling chalk in appearance, for which it is sometimes used, occurs in a lead about four feet thick, uncovered for about one hundred feet.

ZENTGRAFT GOLD QUARTZ MINE.

This mine is situated in the Alabaster Mining District, close to the American River, one and a half miles below Rattlesnake Bar, at a point about eight miles a little east of south from Newcastle, and at the altitude of three hundred feet above the sea.

The course of the vein is northwest and southeast. The dip is southwest from 38 degrees to 40 degrees and the average width is three feet. The length of the pay shoot is not known. The claim is three thousand feet in length by six hundred feet wide. The mine is worked from a tunnel of one thousand two hundred feet on the vein, reaching a depth from the surface of two hundred and fifty feet on the dip, and stoped for a length of eight hundred feet to within thirty feet of the surface. The walls are both granitic for a distance of about seven hundred feet, after which the vein cuts into slate, which rock then forms both of the walls. The only difference observed in the vein when it passes into the slate is that the quartz is more in bunches; that is, the vein varies more in width and the gold is worth more per ounce, namely, $14 in the slate bedrock against $12 in the granite. The transition from granite to slate is not sharp, the two rocks being mixed for some distance. About the junction the vein

was enlarged to a width of at least five feet, forming a large body of good ore, which was stoped out from the tunnel upward. The top of the hill in which the vein occurs is slate.

The tunnel was driven at a cost of $3 per foot, and the ore is extracted for $3 per ton at present. The powder used is Safety Nitro, of which the consumption is from one and one half to two tons per year. Timbering is only required in the stopes, and consists of pine, which costs only the cutting and hauling, being abundant in the vicinity. The company has built two and one half miles of ditch, taking water from the Bear River Ditch Company at a cost of $200 per month. The ore is quartz, with free gold, pyrites, and a little galena, and is treated by wet stamping, amalgamation in battery and on outside plates, and concentration of tailings. The mill is upon the mine, and is driven by an overshot water wheel thirty-six feet in diameter and three feet breast, under one hundred miner's inches of water, measured under four inches of pressure. The mill has ten stamps of seven hundred and fifty pounds each, dropping from six to seven inches seventy times per minute, and crushing one and four tenths tons of ore to each stamp, in twenty-four hours, through brass wire forty-inch screen, of forty-four inches by five inches discharging surface, set vertically. Each battery of five stamps uses four miner's inches of water (four-inch pressure). The shoes and dies are of steel. They are made in this State, and cost 8 cents per pound at the foundry; one set lasts four months, if of good quality. The aprons, silvered, are four feet by three and one half feet, with an inclination of two inches to the foot. Inside plates are from three to six inches wide. Sluice plates are fourteen inches wide and ten feet long to each battery; not silvered. The feeding is done by hand. Of the gold saved, 80 per cent is found in the mortars, and 20 per cent on the aprons, etc. The loss of quicksilver is not given. Concentration of the tailings is effected by means of gunnysacks laid in sluices, the length of which is about two hundred feet. The first product is rewashed in another set of sluices, yielding a clean product amounting to 1 per cent of the weight of ore crushed, and having a value of $126 per ton on an average for one year; the value is mostly in silver, and the material is sold at Reno.

The company is driving a new crosscut tunnel, to cut the vein at one hundred and thirty feet below the present working tunnel. This work is prosecuted night and day, at a cost of $10 per foot; the formation so far cut is granite. The mouth of this tunnel is sixteen feet above the highest water mark ever known in the river, and it is intended to erect a new mill below it. The developments during the year so far have been fifty feet of working tunnel, and some stoping, also one hundred feet in the new tunnel. The mill has to stop during a part of each year on account of scarcity of water; at the present time (July) only five stamps are dropping. The mine employs sixteen men, of whom four are working in the new tunnel; the mill employs three men, and three more are engaged in outside work, making a total of twenty-two men employed by the company. The wages paid per day are, to white men, $2 50; Chinese, $1 75.

Altitude	300 feet.
Length of tunnel	1,200 feet.
Length of ore shoot	Not known.
Depth on incline at end of tunnel	250 feet.
Kind of powder	Safety Nitro.
Quantity of powder used during year	1.5 to 2 tons.
Cost of tunnel (old)	$3 per foot.
Cost of tunnel (new)	$10 per foot.
Cost of mining	$3 per ton of ore.
Length of ditch made	2.5 miles.
Number of stamps	10

Weight of stamps	750 pounds.
Drop of stamps	6 to 7 inches.
Drops	70 per minute.
Duty per stamp	1.4 tons in twenty-four hours.
Kind of shoes and dies	California steel.
Cost of shoes and dies at foundry	8 cents per pound.
Duration of shoes and dies (if good)	4 months.
Size of aprons	4 by 3½ feet.
Length of plated sluices	10 feet.
Width of plated sluices	14 inches.
Width of inside plates	3 to 6 inches.
Percentage of recovery saved in battery	80
Percentage of recovery saved in plates	20
Percentage of sulphurets	1
Value of sulphurets	$126 per ton.
Number of men in mine	16
Number of men in tunnel	4
Number of men in mill	3
Number of men on outside	3
Wages paid whites	$2 50 per day.
Wages paid Chinese	$1 75 per day.
Water used in battery to 5 stamps	4 inches.*
Water used for power	100 inches.
Fall of water for power	36 feet.
Cost of water	$200 per month.

FRESNO COUNTY.

Fresno, meaning in the Spanish an ash tree, was given to this county because much timber of that kind was found growing there. Fresno is bounded on the northwest by Merced and Mariposa Counties; on the northeast by Mono and Inyo; on the southeast and south by Tulare; and on the southwest by Monterey and San Benito Counties.

Fresno being one of the large counties of California, presents a greatly diversified surface, her topography exhibiting a vast expanse of mountains and plains, rolling prairies and foothills, with broad stretches of tule lands along the rivers and sloughs—her natural resources being as large and varied as her topography. The eastern third of the county is a mass of mountains, with the foothill region further down. Between the latter and the base of the Coast Range on the west, stretches an immense plain, treeless and much of it waterless. The mountains are covered with splendid forests and the foothills with a more scattered growth of oak and inferior pine. While the western part of the county is so arid, the eastern is abundantly watered by the many streams issuing from the Sierra Nevada, among them the San Joaquin and Kings Rivers, two of the largest streams in the State.

HILDRETH MINING DISTRICT.

This district is about thirty-five miles northeasterly from Fresno City, near the San Joaquin River. The country rock is granite, with here and there small belts of slate. Wood for timber is scarce, but there is an abundant supply of white oak for firewood.

ABBEY MINE.

This mine is located one half mile east of the town of Hildreth, at an altitude of one thousand seven hundred feet. The property consists of three claims, two one thousand five hundred feet long by six hundred feet in

* Measured under four-inch pressure.

width, the other a parallel claim adjoining one thousand five hundred by six hundred feet. The course of the vein is northeast and southwest, with a northwesterly dip of 26 degrees, and an average width of two feet. The mine is worked through a shaft and a tunnel, the former being six hundred and thirty feet upon the incline, reaching a vertical depth in the mine of four hundred and thirty feet; the tunnel, following the course of the vein, is eight hundred feet in length. The formation of the hanging-wall is granite, that of the foot-wall granite and syenite. There is not much timber in the immediate vicinity. The gold is collected by amalgamation in the battery and on outside plates. Seventy-five per cent of the recovery is obtained in the battery and 25 per cent is collected from the plates. The mill of ten stamps is run by steam power. Each stamp weighs eight hundred pounds, and drops six inches, eighty-six times per minute. The engine in the mill is supplied with steam from the hoisting works, one hundred and seventy-five feet distant.

The mine has been extensively worked and the ledge is steadily improving. On the same level as the tunnel and fifty feet west is the incline shaft following the vein and dipping northerly at an angle of 26 degrees. From the shaft, one hundred and fifty feet from the surface, there is a drift running northeasterly one thousand feet. One hundred and fifty feet deeper on the incline is another drift running also northeasterly a distance of seven hundred and sixty feet. One hundred feet lower (third level) and running in the same direction, they have drifted four hundred feet. On the fourth level the drift extends three hundred feet, and on the fifth level (six hundred feet deep) the drift is two hundred and fifty feet long; both of these levels run northeasterly. The intervening ground between these drifts is now being stoped, and milled with results highly satisfactory to the owners. Running southwesterly from the incline on the second level, three hundred feet from the surface, a drift has been extended one hundred and twenty-five feet. On the third and fourth levels the drifts are one hundred and twenty-five feet and thirty feet long, respectively, both running southwesterly. The ore has averaged in free gold about $25 per ton, and carries nearly 3 per cent of sulphurets assaying $200 per ton. The inside plates are five by twelve inches; they are cleaned up twice a month. The aprons are fifty inches by ten feet; there are no narrow sluices with plates, the pulp running direct from the aprons to the Frue vanners (four in number). The aprons have an inclination of one and one half inches to the foot, and are scraped every day. The batteries are supplied with four Challenge feeders.

The shoes and dies are of adamantine steel. Two and one half tons are crushed per stamp in twenty-four hours, through slot punched, No. 9, screens. Loss of quicksilver is about thirty pounds per month. A set of shoes and dies will crush three hundred and seventy-five tons of ore before requiring renewal. The water in the mine averages twenty-four thousand gallons per day, and is handled by a No. 4 Cameron pump at the bottom of the incline shaft, and a No. 6 Cameron pump at the five hundred-foot level, and is used to supply the boilers. The wood used for fuel amounts to six and one fourth cords per day, costing $3 50 per cord. There are forty-eight miners employed, who receive $2 50 per day. In the mill four men are engaged, who also receive $2 50 per day. On outside work ten men find steady employment at $40 per month and board. The ore shoot is eleven hundred and fifty feet in length. Hercules powder is used in blasting, and of this about nine hundred and fifty pounds per month are consumed. The mine is carefully timbered with pine, costing six cents per linear foot eight inches square.

Altitude	1,700 feet.
Length of ore shoot	1,150 feet.
Length of ore shaft on incline	630 feet.
Vertical depth reached in mine	430 feet.
Quantity of water raised in twenty-four hours	24,000 gallons.
Character of hanging-wall	Granite.
Character of foot-wall	Granite and a little syenite.
Kind of powder used	Hercules.
Quantity of powder used	950 pounds per month.
Number of feet timbered	All timbered.
Kind of timber	Pine.
Cost of timber	6 cents per linear foot 8 by 8 inches.
Length of road built	One half mile.
Length of ditch built	None.
Cost of transport of ore	Nominal.
Character of ore	Quartz.
Number of stamps	10
Weight of stamps	800 pounds.
Drop of stamps	6 inches.
Drops	86 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	Chrome steel.
Size and character of screens	Slot punched, No. 9.
Dimensions of apron	50 inches by 10 feet.
Width of sluice	No sluice.
Kind of feeder	Hendy's Challenge.
Kind of concentrators	Frue's.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	2
Value of sulphurets	$200 per ton.
Number of men in mill	4
Number of men in mine	48
Total number employed	62
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$40 per month and board.
Wood used	6¼ cords per day.
Cost of wood	$3 50 per cord.

HANOVER MINE.

This mine was located in 1880 by H. G. Williams, the present owner. The property consists of a claim three thousand feet wide, and forty acres of land. The course of the vein is northeast and southwest, dipping northerly at an angle of 34 degrees; both walls are granite. The ore shoot is one hundred and ten feet in length. The mine has been opened by two tunnels—one of seventy and the other forty feet in length. An incline shaft has been sunk one hundred and seventy feet, reaching a vertical depth of sixty feet. The flow of water, about one hundred gallons per hour, is handled by a Cameron pump. All work thus far upon the mine has been done by hand drills and Giant powder. The cost in running tunnels has been $12 per foot, and that of sinking the shaft, $15 per foot. Pine wood, which is obtained within a mile of the mine, is used in timbering, costing, delivered at the mine, 7 cents per linear foot, eight inches square. The vein averages twenty inches in width, and the ore carries about 1 per cent of sulphurets (which are saved on the Frue vanner), assaying a little over $100 per ton in gold. A five-stamp, steam power mill, with an iron frame, has been erected at the mouth of the shaft; the stamps weigh eight hundred and fifty pounds each, and drop six inches, eighty times per minute. The shoes and dies are of white iron. Stamps are fed by hand, each crushing one and one quarter tons of ore in twenty-four hours. Seventy per cent of the free gold recovered is from the battery, and 30 per cent from the outside plates. Oak wood for steam purposes, costing $4 per cord, is used for fuel, under a Hitchcock tubular boiler. The engine is a "Homan," of thirty-

five-horse power. The wages paid to miners and mill hands are $2 50 per day. At the time of the visit the mine was not working, but the mill was in active operation on the ore already extracted. It is the intention of the owners to continue sinking the incline, and also open the upper stopes.

Altitude	3,000 feet.
Length of ore shoot	110 feet.
Length of ore shaft on incline	170 feet.
Vertical depth reached in mine	100 feet.
Quantity of water raised in twenty-four hours	1,200 gallons.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Kind of powder used	Giant.
Cost of tunnel	$12 per foot.
Cost of shaft	$15 per foot.
Number of feet timbered	50
Kind of timber	Pine.
Cost of timber	7 cents per linear foot 8 by 8 inches.
Character of ore	Hard white quartz.
Character of works	Stamps.
Number of stamps	5
Weight of stamps	850 pounds.
Drop of stamps	6 inches.
Drops	80 per minute.
Duty of stamp	1¼ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Punched slot, No. 8.
Dimensions of apron	5½ by 8 feet.
Width of sluice	2 feet.
Length of sluice	10 feet.
Kind of feeder	Hand.
Kind of concentrators	1 Frue.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	1
Value of sulphurets	$100 per ton.

MORO MINE.

This mine is situated about one half mile west of the Hanover. The claim is three thousand feet long by six hundred feet wide. Several shafts followed the vein, which dips at an angle of 26 degrees, and has a northeast and southwest course. Both walls are of granite. The quartz is of good grade and free milling. A tunnel one hundred and fifty feet in length (at the time of the visit) was being actively pushed along the course of the vein.

GOLCONDA.

This mine is about one and a half miles northwest from the town of Hildreth, and about five hundred feet higher in altitude. The property, consisting of two parallel claims, is three thousand feet long by twelve hundred feet wide. The course of the vein is northeast and southwest, dipping at an angle of 28 degrees, and the shaft is two hundred and eighty feet deep on the incline. The principal drift, running northeasterly, is at a depth of one hundred and fifty feet and extends ninety feet. Bunches of high grade ore are met with at irregular intervals. The average width of the vein is about ten inches; both walls are granite. An upright boiler and hoisting engine are used at the incline shaft. The company also own a complete five-stamp mill (stamps weighing nine hundred pounds each) and two Frue vanners. On the parallel claim belonging to the same company, the shaft is only fifty feet deep, and the vein is about one foot in width. but dipping in an opposite direction from the vein previously mentioned.

SYCAMORE MINING DISTRICT.

This district is about seventy-five miles easterly from Fresno City, and is reached by a good stage road to the Toll House, forty-four miles from Fresno City. From this point the grade is very steep for about twelve miles—passing through a dense growth of pine, cedar, and fir. At Pine Ridge there are a number of sawmills in active work. From here the road passes over a rolling country covered with pine forests; this dense growth of timber makes prospecting difficult. There are a number of claims located, but very little has been done toward developing them. The formation is exclusively granite from the foothills to the highest peaks.

PROVIDENCE MINE.

This property is the only mine in the district upon which a notable amount of capital has been expended, and was located in 1883. The vein, averaging two feet in width, has a northwest and southeast course, dipping northeasterly at an angle of 28 degrees. The walls are granite, the hanging-wall being a trifle harder than that on the foot. The mine has been opened by an incline shaft, following the dip of the vein to a depth of two hundred feet, reaching a vertical depth of eighty feet. The shaft is well timbered, a double compartment shaft extending down one hundred and twenty feet; the remaining eighty feet is a single compartment. There are three tunnels, one four hundred feet long, which serves as a drain tunnel (the flow of water amounting to five hundred gallons per hour); the other tunnels are respectively one hundred and sixty and eighty feet long. The entire length of the tunnels is timbered with pine and fir, the cost of which is nominal, an abundance of timber growing upon the claim. The cost for mining is estimated at $1 50 per ton. There are two parallel ledges four to five feet apart, and varying in width—from one to three feet. On the one hundred-foot level a drift has been run in an easterly direction one hundred feet; in this drift the upper ledge is ten inches wide, and the lower one three feet wide, both ledges showing ore of very good quality. Seventy-five feet lower another drift has been run, also in an easterly direction, one hundred and ten feet. The ledges here average two to three feet in width. The quartz is honey-combed from the decomposition of the iron pyrites, the oxidized residues imparting to the quartz their characteristic appearance.

The company had on the ground, ready for erection, a Dodge mill of ten tons capacity, and a sixty-horse power engine, made by Henry Nagle, of Boston, with two steel boilers, one twelve feet by forty-four inches, the other ten feet by thirty-six inches; also a double hoisting engine of twenty-horse power. The granite walls are so soft that but very little blasting is required, the drain tunnel (four hundred feet long) consequently costing but $1 25 per foot. A number of tons of the ore from the drifts yielded $22 per ton in arastras.

Length of ore shoot	About 3,000 feet.
Length of ore shaft on incline	200 feet.
Depth of ore shaft vertically	80 feet.
Vertical depth reached in mine	80 feet.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Cost of mining	$1 50 per ton.
Length of tunnels	400, 160, and 80 feet.
Cost of tunnels	$3 per foot.
Number of feet timbered	640 in tunnels, and 200 in shaft.
Kind of timber	Pine and fir.

Cost of timber	Nominal.
Length of road built	2 miles.
Character of works	Dodge pulverizer, capacity 10 tons per twenty-four hours.
Number of men in mine	6
Total number employed	10
Average wages in mine	$3 per day.
Average wages paid outside	$35 per month and board.

MILL CREEK MINING DISTRICT.

This district is about forty-three miles southeast from Fresno City.

SAMPSON MINE.

This mine is located eight miles northeast of the town of Dunlap. The vein has a course north and south, is almost vertical, and has an average width of eight feet. The dimensions of the claim are one thousand five hundred by six hundred feet. Country rock is granite, but the walls inclosing the vein are soft porphyry. The mine is worked through two vertical shafts, having respective depths of forty and seventy feet; both are timbered with yellow pine, which grows abundantly on and about the claim. The ore is quartz, free milling, containing a small amount of sulphurets, and is crushed in a Kendall mill, which is run by an eight-horse power engine. Eight tons of ore are crushed every twenty-four hours, and passed through a round punched, No. 9, screen. The apron and sluices are silver-plated; the former is eight by twenty-four inches, and the latter fourteen inches wide by twenty feet long. The sulphurets are saved on blankets. The water in the mine is handled by an ordinary force pump, run by steam from the boiler of the mill.

Depth of ore shafts vertically	40 and 70 feet.
Vertical depth reached in mine	70 feet.
Quantity of water raised in twenty-four hours	500 gallons.
Character of hanging-wall	Porphyry.
Character of foot-wall	Porphyry.
Kind of powder used	Giant, No. 2.
Cost of mining	$2 per ton.
Number of feet timbered	Both shafts are timbered.
Kind of timber	Yellow pine.
Character of ore	White quartz.
Character of works	Kendall mill, having a capacity of 8 tons in twenty-four hours.
Size and character of screens	Round punched, No. 9.
Dimensions of apron	8 by 24 inches.
Width of sluice	14 inches.
Length of sluice	20 feet.
Kind of feeder	Hand.
Number of men in mill	2
Number of men in mine	6
Total number employed	9
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 50 per day.
Cost of wood	$2 per cord.

ORO FINO MINE.

The mine is situated on Mill Creek, about two miles northeast of the Sampson Mine, but lower in altitude by about one thousand feet. It was located in 1880, and is one thousand five hundred feet long by six hundred feet wide. The vein, averaging three feet in width, has a northwest and southeast course, and dips towards the east at an angle of 45 degrees. Quartz is hard, white, and compact, carrying nearly one per cent of sulphurets. Over twenty tons of ore are now on the dump, which it is expected

will mill $8 per ton. This ore was extracted from a shaft about thirty-five feet in depth. One thousand feet south of this shaft is an open cut on the vein, which has been denuded of the surface dirt by hydraulicking. At this point the vein has been uncovered one hundred feet, showing an average width of three feet. Mill Flat Creek has sufficient water to run a large mill eight months in the year, and the Kings River, only two miles north, can be reached by a road constructed with very little expense.

LIMESTONE.

Around the town of Dunlap, the country rock is granite, traversed at intervals by belts of slate. Water is found a short distance beneath the surface, and oak wood is very abundant. Close to the town are two deposits of limestone; on one of these deposits two lime kilns, of the capacity of one hundred barrels each, are in active operation, making a very fine quality of lime. The other deposit of limestone has not been so extensively developed as the former, but a lime kiln is in operation, producing material of good quality. Both of these deposits carry a small proportion of phosphate of lime. The limestone is cut at intervals by strata of mica schist. On one side of the calcareous deposit there is a capping of oxide of iron about six feet in thickness, imbedded in which large garnet crystals are occasionally found.

WHITE CROSS MINE.

About one mile northwesterly from the town of Dunlap, and five hundred feet higher in altitude, in a slate formation, is a small ledge of quartz. It has a promising appearance, although but little work has been done upon it. The ledge courses north and south, and dips to the west. A few tons of ore have been crushed with satisfactory results. A tunnel is now being run to intersect the vein at a depth of about one hundred and twenty feet. Midway between Dunlap and the White Cross Mine is a ledge of quartz which has most promising surface indications, upon which a tunnel is being run, in order to intersect the ledge at a depth of one hundred and fifty feet.

BIG DRY CREEK DISTRICT.

This district is about twenty-three miles northeast of Fresno City, and begins at the foothills of the Sierra Nevada Mountains. The country rock is principally granite, crossed here and there by belts of slate.

CONFIDENCE MINE.

This mine is two miles northerly from the Letcher Post Office. The vein, averaging in width twenty inches, courses northeast and southwest, dipping easterly at an angle of 45 degrees. The claim is one thousand five hundred by six hundred feet; both walls being slate. There are two ore shoots, each about eighty feet in length, and they are separated by a barren streak also about eighty feet in length. The mine has been opened by means of a tunnel three hundred and sixty feet in length, which intersects the vein at a vertical depth of one hundred and twenty feet. A shaft has been sunk vertically to the tunnel for ventilation. Over one thousand tons of ore have been yielding $8 50 per ton; 50 per cent of the free gold obtained was recovered from the battery, the balance from the outside plates. The ore is quartz, with some talcose rock. The quantity of water in the mine is

trifling. Giant, No. 2, is the explosive used. The cost of running the tunnel was $3 per foot, and that of extracting the ore is $3 per ton. The tunnel and shaft are timbered with six by six-inch pine, which costs $22 per thousand linear feet; the timber is brought from the mountains twenty-five miles distant.

The company has constructed two miles of road and one fourth of a mile of ditch. The mill is situated two miles north of the mine, on Big Dry Creek. It has five stamps of six hundred pounds each, which drop six inches eighty-five times per minute, crushing one ton of ore per stamp every twenty-four hours. The shoes and dies are white metal, one set being used for every three hundred tons of ore crushed. The screen is of wire, No. 60; the apron is four feet by four feet six inches; the plates are eighteen inches wide and twelve feet in length, and the loss of quicksilver is reported as trifling. Ore is almost perfectly free from sulphurets. Five miners extract the ore, and two mill men attend to the amalgamation. Wages in the mine and mill are $3 per day. The power is furnished by an overshot wheel, sixteen feet in diameter and three feet wide, using two hundred inches of water.

Length of ore shoot	160 feet.
Vertical depth reached in mine	120 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Giant, No. 2.
Cost of mining	$3 per ton.
Length of tunnel	360 feet.
Cost of tunnel	$3 per foot.
Number of feet timbered	360
Kind of timber	Pine.
Cost of timber	$22 per thousand.
Length of road built	2 miles.
Length of ditch built	One fourth mile.
Cost of transport of ore	75 cents.
Character of ore	Quartz and talcose rock.
Character of works	Stamps.
Number of stamps	5
Weight of stamps	600 pounds.
Drop of stamps	6 inches.
Drops	85 per minute.
Duty of stamp	1 ton in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Wire, No. 60.
Dimensions of apron	4 by 4½ feet.
Width of sluice	18 inches.
Length of sluice	12 feet.
Percentage of gold saved in battery	50
Percentage of gold saved on plates	50
Percentage of sulphurets	Traces.
Number of men in mill	2
Number of men in mine	5
Total number employed	7
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Water used for power	200 inches.

MONTE CRISTO.

This claim, three quarters of a mile southerly from the Confidence, has been opened by a tunnel following the course of the vein for two hundred and twenty feet. The ledge is about one foot in width inclosed by slate walls, and the ore is prospected by an arastra. Two miles northeast of the Confidence mine there is a deposit of red oxide of copper. A number of tons have been extracted and are now on the dump.

FINE GOLD GULCH DISTRICT.

This district is a few miles north of the town of Hildreth.

LILLIE MINE.

This mine is five miles northwesterly from Hildreth. The course of the vein is southwest and northeast, dipping towards the north at an angle of 45 degrees. The average width of the vein is five feet, and the dimensions of the claim are fifteen hundred feet long by six hundred feet wide. The mine has been opened by an incline shaft, which follows the dip of the vein. In August the shaft had reached the depth of three hundred and eighty feet on the incline, which is equal to a vertical depth of one hundred and ninety feet, and is well timbered with pine eight inches square, which costs eight cents per lineal foot; the timber is transported a distance of twenty miles. The cost per foot in sinking the shaft so far has been $15. No drifts have been run as yet, and the work of sinking the shaft is still progressing. A double hoisting engine, six by twelve-inch cylinder, of thirty-five-horse power, is run by an upright steel boiler forty-four inches in diameter and eight feet six inches high. Eight men are employed in the mine, who receive $3 per day. Three cords of wood are used per day, which costs $3 25 per cord. About one hundred and twenty-five gallons of water per hour comes into the shaft, which is readily removed by bucket and utilized for the boiler.

ZEBRA MINE.

This mine is situated about eight miles northeasterly from Hildreth, and was located in 1863 by the present owner. The course of the vein is northeast and southwest, dipping towards the south at an angle of 30 degrees. The average width of the vein is about sixteen inches. The claim is four thousand five hundred feet in length by six hundred feet wide; the length of the ore shoot is five hundred and fifty feet. There are four tunnels; the upper tunnel, or No. 1, is three hundred and eighty feet in length; the remaining three are each fifty feet lower, and have a length respectively of four hundred, three hundred, and five hundred feet. The quartz is easily extracted and carries about 3 per cent of sulphurets. Both walls are granite.

Length of ore shoot	550 feet.
Vertical depth reached in mine	160 feet.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Length of tunnel	Upper, No. 1, 380 feet; No. 2, 400 feet; No. 3, 300 feet; No. 4, 500 feet.
Number of feet timbered	Very little needed.
Kind of timber	Pine.
Cost of timber	8 cents per linear foot, 8 by 8 inches.
Length of road built	1½ miles.
Character of ore	Quartz carrying about 3 per cent of sulphurets.

MINE D'OR DE QUARTZ MOUNTAIN.

This mine is situated about five miles northerly from Coarse Gold Gulch, and ten miles northeasterly from the town of Hildreth. The company own eight quartz claims and four placer locations. The titles are United States patents. On the largest vein in the group an incline shaft has been sunk to a depth of two hundred and fifty feet, well timbered, and supplied with a forty-horse power double hoisting engine and boiler. A sixty-stamp

mill has been erected by the company; thirty of these stamps are fitted with copper plates and six Frue vanners, and the remaining thirty are connected with amalgamating pans for the continuous Boss process. The property is now in litigation and the mine is idle.

Length of ore shoot	500 feet.
Length of ore shaft on incline	225 feet.
Vertical depth reached in mine	110 feet.
Character of hanging-wall	Granite and porphyry.
Character of foot-wall	Granite and slate.
Kind of powder used	Giant.
Length of tunnel	500 feet.
Number of feet timbered	Shaft, 225; tunnel, 500.
Kind of timber	Pine.
Cost of timber	7 cents per linear foot, 8 by 8 inches.
Length of ditch built	4 miles.
Character of ore	Hard quartz, with arsenical pyrites.
Number of stamps	60
Weight of stamps	900 pounds.
Drop of stamps	4½ inches.
Drops	80 per minute.
Duty of stamp	1¼ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Punched slot, Nos. 8 and 9.
Dimensions of apron	4½ by 5 feet.
Width of sluice	2 feet.
Length of sluice	16 feet.
Kind of feeder	Choronat.
Kind of pans	Boss Centennial.
Number of pans	6
Kind of concentrators	6 Frues.

LAST CHANCE MINE.

This mine is situated near the upper end of Fine Gold Gulch, five miles northwesterly from Coarse Gold Gulch Post Office. The claim is four thousand five hundred feet in length by six hundred feet wide. The course of the vein is northeast and southwest, dipping to the northeast at an angle of 35 degrees, with an average width of three feet. There are two ore shoots, having a length of one hundred feet and one hundred and fifty feet, respectively. The mine has been opened by two tunnels. In the upper tunnel, one hundred feet from its mouth, the ledge was intersected at a depth of one hundred and twenty feet; a drift was then run on the ledge for six hundred feet. The lower tunnel is now in four hundred feet, but has not yet reached the ledge. About three hundred feet of the upper tunnel and drift and one hundred and fifty feet of the lower tunnel are timbered with pine eight inches square, at a cost of 8 cents per running foot. The walls are slate. The ore is mined at an expense of $2 50 per ton, and is carried two miles by wagon to the mill, at an additional expense of 75 cents. The mill is ten stamps, each stamp weighing nine hundred pounds, and dropping five and one half inches eighty times per minute, and crushing one and one eighth tons of ore in twenty-four hours. The shoes and dies are steel. The quartz is first broken by a Blake crusher, and fed into the batteries by two Dodge automatic feeders. The mill is run by a forty-horse power horizontal engine (two-foot stroke). The boiler is horizontal, four feet by sixteen feet. Wire screens, No. 50, set vertically, are used. The apron is copper, silverplated, four and one half feet by ten feet, connected with a sluice box two feet wide and sixteen feet long, lined with silvered plates, with an inclination of eighteen inches in sixteen feet. The concentrations are saved on the Frue vanners. The ore carries 2 per cent of sulphurets, having an average assay value of $150 per ton in gold. In the battery 70 per cent of the gold recovered is obtained, and from the apron

and adjacent plates 30 per cent. Six men are employed in the mine and two in the mill, at $3 per day. On outside work two men are engaged, receiving $2 50 per day. Five cords of oak wood are used per day for fuel, at a cost of $4 per cord.

Length of ore shoot	250 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Slate and syenite.
Kind of powder used	Giant.
Cost of mining	$2 50 per ton.
Length of tunnel	One of 400 feet and one of 100 feet.
Number of feet timbered	450
Kind of timber	Pine.
Cost of timber	8 cents per linear foot, 8 by 8 inches.
Cost of transport of ore	75 cents.
Character of ore	Quartz, slate, and 2 per cent sulphurets.
Number of stamps	10
Weight of stamps	900 pounds.
Drop of stamps	5½ inches.
Drops	80 per minute.
Duty of stamp	1⅛ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Wire, No. 50
Dimensions of apron	4½ by 10 feet.
Width of sluice	2 feet.
Length of sluice	16 feet.
Kind of feeder	Dodge.
Kind of concentrators	2 Frue.
Character of ore	Quartz and slate.
Percentage of gold saved in battery	70
Percentage of gold saved on plates	30
Percentage of sulphurets	2
Value of sulphurets	$200 per ton.
Number of men in mill	2
Number of men in mine	6
Total number employed	10
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 50 per day.
Wood used	4½ cords per day.
Cost of wood	$4 per cord.

TEXAS FLAT MINE.

This property is situated about one and one half miles northwest of Coarse Gold Gulch Creek; was located in 1866, and includes a group of five claims, having a total length of seventy-five hundred feet. The course of the vein is north and south, dipping to the southeast at an angle of 35 degrees. The average width of the vein is about five feet. There are four ore shoots now exposed, which have an aggregate length of five hundred feet. The principal work is carried on through a tunnel run on the vein for over one thousand feet, reaching a vertical depth in the mine of three hundred and fifty feet. From this there have been two shafts sunk, one hundred feet apart to a depth of one hundred and seventy feet; below the tunnel level they follow the dip of the vein and are connected by a drift from their lowest points. The walls are slate, and the pay ore occurs in bunches and carries a large percentage of sulphurets. There is very little water in the mine, the total flow not exceeding fifty gallons per hour. The cost per foot for running tunnel was $3 50; for sinking the shafts, $6. Both tunnels and shaft are timbered with pine eight inches square, which costs 6 cents per lineal foot; the timber is hauled four miles. The vein matter is quartz, intermixed with some slate; it is easily mined, very little blasting being required. There are about eight hundred tons of ore on the dump, which is estimated to have an average value of $15 per ton.

Length of ore shoot	500 feet.
Length of ore shafts on incline (two) each	170 feet.
Vertical depth reached in mine	350 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Giant.
Length of tunnel	1,000 feet.
Cost of tunnel	$3 50 per foot.
Cost of shaft	$6 per foot.
Number of feet timbered	1,020
Kind of timber	Pine.
Cost of timber	6 cents per lineal foot, 6 by 6 inches.
Character of ore	Quartz, carrying about 2½ per cent of sulphurets.

COUNTY VIEW MINE.

This mine is located about one and one half miles northwesterly from the Texas Flat Mine, on the same belt of slate, and is considered to be a continuation of the former—the ore in both mines being very similar in character. The only work done upon this claim is a tunnel six hundred feet in length, which is run on the course of the vein—that is, southeast and northwest. At the end of the tunnel there is a crosscut forty feet long in the vein matter, and in the center of this ledge material there is eighteen feet of black ore, heavily sulphureted. The vertical depth in this crosscut is nearly three hundred feet.

THE FLYING DUTCHMAN,

Located about half way between Coarse Gold Gulch and Grub Gulch, near the Fresno River. The course of the vein is northeast and southwest, dipping to the north at an angle of 35 degrees. The mine has been opened by an incline shaft, one hundred feet in depth. The surface ore, where the sulphurets were oxidized, yielded, in free gold, $8 50 per ton. The walls are of slate. Wood is plentiful, and the Fresno River is only a mile distant.

JOSEPHINE MINE.

This property is about one fourth of a mile distant from Grub Gulch, and is owned by an English company. The vein, having a northeast and southwest course, dips to the south at an angle of 45 degrees, and is about five feet in width. The hanging-wall is granite, and the foot-wall slate. The claim is three thousand feet long by six hundred feet wide. The length of the ore shoot now exposed is four hundred and fifty feet. There is an incline shaft, costing $10 per foot, four hundred feet deep, reaching a vertical depth in the mine of three hundred and forty feet, well timbered with fir and sugar pine. Twenty-seven hundred gallons of water per hour are handled by a Cornish plunger and jackhead pump. The water is utilized for steam for hoisting works and mill. Three levels have been opened. The hoisting works are supplied with a double hoisting engine (automatic Corliss). The same boiler furnishes steam to both the hoisting engine and pump. There are twenty stamps, each stamp weighing nine hundred pounds, dropping five inches, eighty times per minute, and reducing two and one half tons of ore in twenty-four hours. Shoes and dies are adamantine steel. The ore is fed to the batteries by Hendy Challenge feeders. The screens are slot punched, Nos. 8 and 9, inclined in the batteries. The aprons are five by six feet, connected with sluices

eighteen inches wide and eighteen feet long. Plates in the battery are silvered, and are four by twelve inches. The ore carries 3 per cent of arsenical pyrites, assaying $150 per ton in gold, which are to be treated in the chlorination works in course of construction. The roasting furnace is to be a "three-hearth," and the capacity of the plant two and one half tons per twenty-four hours.

Length of ore shoot	450 feet.
Length of ore shaft on incline	400 feet.
Vertical depth reached in mine	340 feet.
Quantity of water raised in twenty-four hours	64,800 gallons.
Character of hanging-wall	Granite and slate.
Character of foot-wall	Slate.
Kind of powder used	Giant, No. 2.
Cost of mining	$3 per ton.
Cost of tunnel	$2 50 per foot.
Cost of shaft	$10 per foot.
Number of feet timbered	400
Kind of timber	Fir and pine.
Cost of timber	3 cents per linear foot.
Character of ore	Quartz.
Number of stamps	20
Weight of stamps	900 pounds.
Drop of stamp	5 inches.
Drops	80 per minute.
Duty of stamps	2½ tons in twenty-four hours.
Kind of shoes and dies	Adamantine steel.
Size and character of screens	Slot punched, Nos. 8 and 9.
Dimensions of apron	5 by 6 feet.
Width of sluice	18 inches.
Length of sluice	18 feet.
Kind of feeder	Challenge.
Kind of concentrators	8 Frue.
Percentage of gold saved in battery	60
Percentage of gold saved on plates	40
Percentage of sulphurets	3
Value of sulphurets	$150 per ton.
Number of men in mill	10
Number of men in mine	50
Total number of men employed	65
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 50 per day.
Wood used	5 cords per day.
Cost of wood	$5 per cord.

CRYSTAL SPRING MINE.

This property, consisting of five locations of the regulation size, on the same ledge, lies about two miles northeasterly from the Josephine Mine, and is four hundred feet higher in altitude. The vein is inclosed by slate walls, is about two feet wide, has a northeast and southwest course, and dips easterly at an angle of 50 degrees. A few tons of the ore have been worked at the Josephine Mill, yielding $25 per ton in free gold. The Red Rover has an incline shaft, following the ledge, one hundred and forty-five feet deep; the Investigation has an incline one hundred and seventy feet deep; the Crystal Spring one of seventy feet deep, and the Southwestern one of fifty feet deep.

TEMPERANCE FLAT MINING DISTRICT.

This district is on the southern bank of the San Joaquin River, about five miles southeast of Hildreth.

SULLIVAN MINE.

The course of the vein is northeast and southwest, dipping northerly at an angle of 45 degrees; walls are granite, and the vein averaging two feet in width. The claim is three thousand feet long by six hundred feet wide. Four inclines have been sunk on the vein, ranging in depth from thirty to seventy-five feet. The ingress of water, and a change from oxidized ores to sulphureted ores, caused a cessation of work in depth. Three hundred tons of ore, worked in arrastras, have yielded an average of $33 per ton. A placer claim just below, and up to the Sullivan ledge, has been worked for a great many years profitably in the rainy season, when water is attainable from the mountains.

RATTLESNAKE MINE.

Two miles southwest of the Sullivan Mine, and one fourth of a mile from the San Joaquin River, is the Rattlesnake Mine. The course of the vein is northwest and southeast, dipping northerly at an angle of 26 degrees. The vein has been tapped by a tunnel one hundred feet in length at a depth of seventy-five feet. From the end of this tunnel a drift has been run on the vein northwesterly three hundred feet. Following the vein on the southeast the drift has been extended two hundred and eighty feet, making a total length of five hundred and eighty feet on the ledge. In this southerly drift, one hundred feet from the end of the tunnel, there is an incline shaft, following the dip of the ledge to a depth of eighty feet below the level of the tunnel. The vein, as developed by these drifts and shafts, has a width varying from twenty inches to three feet. The ore carries a large percentage of oxide of iron, is easily mined, requiring but very little blasting, and there are about five hundred tons on the dump from which a milling return of $12 per ton is expected. Another claim, owned by D. D. Jackson, is located one half mile northeast of the Rattlesnake. The course of this vein is northwest and southeast, dipping towards the east at an angle of 45 degrees. The surface prospects are exceedingly promising.

MOUNT RAYMOND MINING DISTRICT.

This district is in the northeasterly corner of Fresno County, about four miles easterly from the Big Trees of Mariposa County. Granite and porphyry are the predominating country rocks. The altitude of the district is about eight thousand feet.

STAR MINE.

The course of the vein is southwest and northeast, and is located on the summit of Mount Raymond. There has been but very little work on the mine, consisting only of a few open cuts and a shaft thirty feet deep. On the surface there can be seen in bunches thousands of tons of galena, carrying a few ounces of silver per ton.

At the site of the reduction works of the Star Mining and Milling Company a large mill building has been erected, one hundred and thirty-six feet in length by sixty feet in width, a portion of the roof being sixty-eight feet from the ground, the remainder forty-five feet, in which to set up the machinery for concentrating, and the stone foundations are laid for securing it in a very solid and substantial manner. The company has most of its machinery on the ground. Work is being pushed on the tramway, and it is expected to be running by the thirteenth of December.

The capacity of these works will be one hundred and twenty-five tons in twenty-four hours, but the building and most of the machinery will permit of this being doubled when deemed necessary. A mammoth Blake rock crusher will prepare the ore for the Cornish rolls, from which it will pass through several screens of different fineness to the German jiggers. The ore that each screen rejects is carried back automatically to the rolls to be crushed over. From the jigs it passes down to a table where it is still further concentrated by water, and from there the concentrations will be drawn off into sacks and the slums carried on to buddles, which extract all of value that may have escaped above.

The machinery is run by water, and works so nearly automatically that very few men are required in the mill, and the total cost of concentrating will be but 50 cents per ton. The tramway will be seven thousand feet in length, and Mr. Haberlein estimates the cost of mining and transporting the ores to the mill at $1 25 per ton. The ore is estimated to be worth $17 per ton in lead and silver. Six tons of crude ore make one of concentrations. The whole plant will cost about $40,000.

HUMBOLDT COUNTY.

This county is bounded on the north by Siskiyou and Del Norte Counties, on the east by Siskiyou and Trinity Counties, and on the west by the Pacific Ocean. The county seat is Eureka, situated on Humboldt Bay, a prosperous town of about six thousand inhabitants.

The principal interest is lumbering, although there is considerable mining done in this county. With immense forests of redwood and other kinds of timber, Humboldt is considered the principal lumber section of Northern California, and this valuable resource has been turned to the best account. The redwood belt varies from eight to twelve miles in width, and extends north and south the entire distance of the coast line—one hundred and eight miles. Large areas of this county are also adapted to grazing, farming, and dairying.

With these important interests to engage the attention of its people, the mineral resources of the county have been comparatively overlooked. At the same time, there are in the northern portion twenty-seven sections, equaling one hundred and sixty-two square miles of land, more valuable for mineral than for anything else. A large portion of this area is covered with a dense growth of timber, and some of it is suited for agriculture.

The Hoopa Reservation, in the valley of that name, comprises an area of one hundred and forty-four square miles, through which the Trinity River, with the same terrace or bench formation of auriferous gravel along its banks, described in the report on Siskiyou County. The value of these deposits is well known, but no white man is allowed by the United States army officers in charge of the reservation post to work them.

Humboldt County has also petroleum, found in an area of from thirty to forty square miles, with the accompanying natural gas. Beds of coal are also found in the same vicinity with marble and other building stone.

GOLD BLUFF BEACH EXTENSION.

At a point eight miles southerly from the mouth of the Klamath River, on the ocean beach at Osegon Creek, the northerly extension of the Gold Bluff Beach, black sand deposits may be seen. These deposits created

much excitement some thirty-five or thirty-six years ago. They extend from Osegon Creek eight miles in a southerly direction. The whole line of the beach was worked for the gold the sand contained. This deposit of black sand contains traces of platinum, osmium—iridium too minute to have any commercial value, but with sufficient gold to make the business of gathering it lucrative. Several parties engaged in this auriferous harvest have retired with a competency. From the date of discovery to the present writing these beaches have been annually worked, success depending, more or less, on the occurrence of fierce gales of wind in the winter time, and the consequently heavy surf that breaks along the shore. These black sands, as they are called, come from the disintegration of the bluffs facing the ocean, and which rise nearly vertical to a height of from one hundred to eight hundred feet above sea level. The bluffs are a formation of auriferous gravels deposited by the Klamath and its tributaries, the main river emptying into the sea centuries ago at this point. The bank caves, and the retreating waves carry the lighter detritus seaward, while the metallic portion remains on the beach in thin sheets, which the miner gathers and washes. This gold is from 900 to 950 fine, and sells for $19 50 per ounce. It is estimated that over $1,000,000 have been taken from this source with comparatively small expense. The banks are still producing, but not so largely as formerly. A heavy bar has formed outside, and the force of attack by the waves on the gravel banks thus diminished. The gravel of which this formation consists can be traced for a distance of more than five miles back from the shore of the ocean, and, according to the observations made, for twenty miles to the Klamath River, near its junction with the Trinity. The auriferous portion of the beach is now divided into two claims, or holdings, known as the Upper Gold Bluff, owned by an Oakland capitalist, and worked under the name of—

THE PIONEER PLACER MINE.

This mine is situated in T. 11 N., R. 1 E., H. M., and contains one hundred and forty-four acres of ground held by United States patent, with four miles of frontage on the ocean. Of this property no official data have been furnished. It is located on the scene of the first excitement, and, as is well known, has produced largely. The prorpietor is not, however, working the beach at present with his usual energy, but is making preparations to hydraulic the immense deposits of gold-bearing gravel in the banks. The second claim, or Lower Beach, is known as—

THE UNION GOLD BLUFF MINING COMPANY,

And also consists of four consecutive miles, next south of the Pioneer. This claim has been regularly worked each season since its location. By referring to the books of the company, it is found that the yield has been as follows: From 1877 to 1883, $147,733 16; expenses, $54,000; profits, $93,733 16. Since 1883 no data have been furnished, though according to reliable information the washings have been continued, and yielded at a uniform rate.

On the Klamath, for a distance of thirty miles from its mouth, gold has not been found in paying quantities. A short distance below the mouth of the Trinity River, the terraces, or benches, covering old river channels appear, and can be followed to its junction with the Salmon, six miles northeast of Somes Bar, on the boundary line between Siskiyou and Humboldt Counties.

At a point twenty-five miles from the river's mouth Klamath Bluff is reached, and the first signs of mining activity are seen. This is the point where at some remote period the river diverged.

THE SURGOYNE HYDRAULIC MINING CLAIM

Has four well defined river branches, or old channels, lying one above the other, terrace like, and varying from one hundred to nine hundred feet in height, and from one to one mile and a half wide from rim to rim, at right angles with the present river channel, indicative of the width of the river at this point before the change in its course. Work is being done on the second bench above the present river bed, carrying one hundred feet of a bank, with from twenty-five to thirty feet of gravel. One No. 2 Giant is used, with four and four and one half-inch nozzles, with one thousand feet of fourteen and sixteen-inch pipe; six hundred inches of water, with two hundred feet of pressure head, from Peckwerrys Creek. Length of flume and ditch, one mile and a half. The mine employs four men, working in the daytime only. Owner reports $7 to $8 to the hand. Wages, $2 50 per day.

WASS'S HYDRAULIC CLAIM.

Passing up the river this claim is reached. It has a frontage of two thousand five hundred feet, and work is carried on in the second bench, one hundred and fifty feet above the river bed. The banks are fifty feet with twenty-five feet of gravel. Five hundred inches of water are used, with two hundred and twenty-five feet of pressure head, and one thousand feet of fifteen and sixteen-inch pipe. Four men are employed during daytime.

LOW AND BROWN SLUICING AND HYDRAULIC CLAIM.

At the junction of the Klamath and Trinity Rivers, thirty-six miles from the mouth of the former, at Witzpeck Bar, the claim mentioned is located. It has five thousand two hundred feet frontage on the river, and is now working a twenty-five-foot bank, all in gravel, on a high bar of the present river bed. Five hundred inches of water, taken from Trinity River, are used, under a pressure head of two hundred feet. The mine is reported as not paying more than wages, $2 50 per day.

SMALL CLAIMS.

From this point, following the Trinity River up to the boundary line of the county, the Hoopa Indian Reservation is passed. This reservation is all rich mineral land, but is not allowed to be worked. Beyond are seven miles of river channel and bank before reaching the boundary line. For this distance there are quite a number of claims in operation, worked on the hydraulic plan; but on account of the lack of capital and water the work is desultory. Although the gravel is said to be rich, the owners are poor, and barely make wages. They are holding their claims for better times.

SAINTS REST.

Returning to the west bank of the Klamath, two miles above the Trinity, the claim with this peculiar name is found. It is worked by four men, with a hydraulic equipment.

BIG BAR HYDRAULIC CLAIM

Is six miles distant. It embraces sixty acres, and shows three benches, the second being worked at present. Six hundred inches of water are being used, with a four hundred-foot pressure head, a three-foot flume, one No. 2 Giant, with one thousand five hundred feet of fifteen and sixteen-inch pipe, four and four and one half-inch nozzles. Mine is reported to be paying well.

FRENCH BAR HYDRAULIC COMPANY'S CLAIM

Has thirty acres, with three benches, work now going forward on the second. This shows one hundred feet of bank with ten feet of gravel. One No. 2 Giant, with one thousand feet of fourteen and sixteen-inch pipe, are in service when the mine is in operation; but it is now lying idle for want of water, of which it requires five hundred inches, with one hundred and fifty feet of pressure head.

THE RED CAP

Lies one mile distant. This claim embraces seventy acres of ground, on which there are three benches, with fifty feet of bank and thirty of gravel. One No. 2 Giant and nine hundred feet of fourteen and sixteen-inch pipe are in use. The claim is run by three men. Output unknown.

TWO YOKE BAR HYDRAULIC MINING CLAIM.

About two miles from this point, has fifty acres of ground, and uses one No. 2 Giant, with five hundred feet of pipe. There is three fourths of a mile of forty-inch flume, with eighteen-inch sides, set at a grade of four inches to the rod; it carries one thousand inches of water, with four hundred feet of pressure head. Claim worked by four men. Output unknown.

SAROORANA HYDRAULIC MINING COMPANY

Has the next claim adjoining, operated by the Jim Chin Company (Chinese), under a lease. This property has eight hundred feet frontage on the river; two benches, with fifty feet of bank and twelve feet of gravel; and employs eight men—day work only. Uses a No. 2 Giant, with nozzles three and one half and four and one half inches; twelve hundred feet fourteen and sixteen-inch pipe; eight hundred inches of water, with a pressure head of one hundred and twenty feet. Reported a playing claim.

THE FERRIS HYDRAULIC MINING COMPANY'S CLAIM

Is reached in a distance of four miles northerly. The ground embraces one hundred acres, for which a United States patent has been applied. The bank is forty feet high, with ten feet of gravel, reported rich, but the owners are without capital to bring in water. Claim is now being worked with a small stream, with light head. Three men are employed at $2 25 per day.

ORLEANS BAR.

This place is at an elevation of five hundred and nineteen feet above the sea level and forty-four feet above the river bed, located in Sec. 31, T. 11 N., R. 6 E., M. D. M., on the Klamath River, six miles southeast from the

county boundary line, on the contour of the river. On the west bank of the river, and in the vicinity of the town, extensive properties are operated by

THE ORLEANS MINING COMPANY (LIMITED),

A London incorporation, that has expended within the past year over $75,000 in improving the claim, building ditches, canals, flumes, reservoirs, and other appliances for effective and extensive mining. The company holds one thousand three hundred and ten acres of mining ground, and within that area are four well defined back channels, rising in steps or terraces above the river bed, at varying elevations. The portion of the claim now worked is on the second bench, at a height of one hundred and fifty feet, with a bank forty feet high, carrying ten feet of pay gravel. This mine is worked day and night, by twelve men, including the manager. During one month three superficial acres of gravel are moved, with three thousand inches of water, under a pressure head of one hundred and twenty-five feet. Two Giants, Nos. 2 and 4, with four and six-inch nozzles, are in use, and one thousand feet of sixteen, seventeen and one half, and twenty-two and one half-inch main pipe. The sluices are four hundred and twenty feet long, with a grade of eight inches in twelve feet; size, three by two feet. Block riffles are preferred. The company has constructed, this season, ten and one half miles of main ditch and flume, and six hundred and five yards of branch ditch, equal to eighteen thousand four hundred and eighty yards. Water supply is taken from Camp, Big, and Little Wilder Creeks and their several tributaries. The ditches measure eight feet three inches by five and one half feet by two feet nine inches; flumes, six and one quarter by four feet; grade of both ditch and flume, ten feet to the mile. For seven months the supply of water is three thousand inches; for two months, one thousand inches; for three months, five hundred inches. There are two distributing reservoirs. The lower furnishes a pressure head of one hundred and twenty-five feet; the upper, two hundred feet. Camp Creek has been tapped by five hundred and twenty feet of tunnel. Seventy-five pounds of quicksilver are in use, with a loss of one sixth each month. The head boxes are cleaned up every ten days, and each fifteen days the riffle blocks are turned. Wages paid, $40 to $50 per month, with board, for miners; $65 per month and board, for pipemen. The foreman gets $4 per day. The officers of the company state that, notwithstanding the shortness of the season, and the large amount of expensive deadwork done, the returns from the claim are quite satisfactory.

PERCHE HYDRAULIC PLACER CLAIM.

On the east side of the river, a short distance above the English company's claim, this property attracts attention. The elevation of the river at a point opposite is four hundred and eighty-one feet above sea level. The Perche has a frontage of seven hundred and fifty feet on the river front, and extends back to the dividing ridge, with three well defined channels, or terraces. The bench (second) now worked is at an elevation of one hundred and eighty feet above the bed of the river. Bank is sixty-five feet in height, with thirty-five feet of gravel. A few heavy bowlders occur on the bedrock, which are moved by a team of oxen; the heavier bowlders are moved by the parbuckle—a purchase formed by a single rope. Two No. 2 Giants are in use, with three, four, five, and six-inch nozzles; two thousand feet of fifteen, eighteen, and twenty-two-inch pipe—

with eleven and thirteen-inch pipe to finish up with. The sluices are one thousand one hundred and fifty-two feet in length; size, thirty by thirty inches; block riffles are used. The grade is six inches to twelve feet. It is found that the greater portion of the gold is caught in the first eight of the ninety-six boxes forming the length of the sluice system; the fineness of gold is 825. Head sluices are cleaned up every week.

Water is taken from Mill Creek. The season lasts seven months, and during that time the supply is three thousand inches, under a six-inch pressure head. Two ditches and a flume are owned by the company, the extreme length being one mile and a quarter. Ditch No. 1 measures four feet on top, two on the bottom, and is eighteen inches deep, with a grade of two inches to the rod; Ditch No. 2 is three quarters of a mile long, and of the same size and grade; the flume (No. 3) is half a mile long, eighteen inches wide, and twelve inches deep. There is also a distributing reservoir, with an area of sixty by one hundred and twenty yards, and a depth of seven feet. During the seasons of water supply, one hundred and forty square rods of gravel, superficial area, by sixty-five feet in depth, are washed away. The output of this claim is unknown. It has been worked in a systematic manner for several years.

MARKERSON HYDRAULIC PLACER GOLD MINING COMPANY.

One mile up the river the claim known by this name is located, with a frontage on the stream of two thousand two hundred and fifty-six feet, and extending back to the divide. The ground shows three terraces, or remains, of the old river channels. At present work is being prosecuted on the second bench, and a No. 2 Giant, with eight hundred feet of fourteen-inch pipe, is used. Sixty feet of bank have been exposed, showing twelve feet of pay gravel, which is washed through two hundred and fifty feet of sluices, in size twenty-four by twenty-four inches, with a grade of nine inches to twelve feet. Water is conducted from Nelson Creek, in a flume two miles long, and in dimensions twenty-four by eighteen inches, with two and one fourth-inch grade to the rod. Three hundred inches are conveyed and delivered, with a pressure head of one hundred feet. Thirty pounds of Giant powder are consumed during each season, which lasts from five to six months. This claim is reported to clean up from $3,000 to $4,000 per season, with four men employed, at $35 per month and board.

THE USCILLINA HYDRAULIC MINE

Is the next in order, with the usual three benches, or terraces, and a frontage on the river of one thousand feet. The second bench is the scene of operations, where a sixty-foot bank is shown carrying twelve feet of gravel. The work is carried on by two men, with one No. 2 Giant, three-inch nozzle, six hundred feet of pipe, with a pressure of two hundred feet. Three hundred inches of water are used. The work on this claim is not carried on regularly.

NELSON HYDRAULIC PLACER CLAIM

Adjoins the claim last named. It is situated on the north bank of the Klamath, at a point near the junction of the Salmon River, and embraces one hundred acres of ground, handled by five men, who are now doing work on the first bench. Forty feet of bank are visible, with twelve feet of pay gravel. Seven hundred inches of water are delivered at the mine, with a

two hundred-foot head. This claim has many heavy bowlders that require blasting, and for this purpose two hundred and fifty to three hundred pounds of No. 1 Giant powder are consumed during the season of from six to eight months. One No. 2 Giant, with a six-inch nozzle, is in use, and one undercurrent. The sluices are one hundred and fifty feet long, and in size twenty-four by eighteen inches; grade eight inches to the box of fourteen feet. The gold is coarse, and the mine is reported to be paying well.

From this point to the Siskiyou boundary line, three miles distant, there are no claims worthy of mention being worked.

THE YEARLY PRODUCT.

It is impossible to ascertain with any certainty the yearly output of gold in Humboldt County.

HUMBOLDT COUNTY.

Tabulated Statement of Gravel Mines in Operation during the Water Season.

Names of Mines and Locality.	Class of Mine.	Number and Size of Giants	Diameter of Pipe, in Inches	No. Inches Water Used Under a 6-Inch P. H.	Number of Men Employed	Length of Season, in Months	Area of Ground, in Acres	Length of Flumes and Ditches, in Miles	P. H. of Water at Bench	Length of Sluices, in Feet	Number Benches	Height of Banks, in Feet	Thickness of Pay Gravel, in Feet	Character of Pay Gravel
Gold Bluff.														
Pioneer Placer*	Beach Mine	......	......	......	8	8	1,440	......	......	......	......	......	......	......
Union Gold Bluff	Beach Mine	......	......	......	8	8	1,440	......	......	......	......	......	......	......
Klamath River.														
Surgoyne	Hydraulic	1 No. 2	14 and 16	600	4	8	40	2½	200	250	4	100	25	Light.
Wass	Hydraulic	1 No. 2	15 and 16	500	4	8	80	1	225	300	3	50	25	Light.
Lord & Brown	Hydraulic	1 No. 2	12 and 14	500	5	8	150	3½	200	200	3	25	25	Light.
Saints Rest	Hydraulic	1 No. 2	14 and 16	......	......	8	......	......	......	......	3	......	......	Light.
Big Bar	Hydraulic	1 No. 2	15 and 16	600	6	8	60	2	400	225	3	80	20	Light.
French Bar	Hydraulic	1 No. 2	14 and 16	500	8	8	70	1½	150	210	3	100	10	Light.
Red Cap	Hydraulic	1 No. 2	14 and 16	500	3	8	50	2	125	200	3	50	30	Light.
Two Yoke Bar	Hydraulic	1 No. 2	12 and 14	1,000	2	8	50	1	400	210	3	40	10	Light.
Saroorana	Hydraulic	1 No. 2	14 and 16	800	8	8	80	2	120	275	2	50	12	Heavy.
Orleans Mining Company (Lim. English)†	Hydraulic	1 No. 2 1 No. 4	16 to 22½	3,000	12	8	1,310	11	125 to 350	420	4	40 to 100	10 to 40	Med.
Ferris Mining Company	Hydraulic	1 No. 2	12 and 14	400	3	8	100	1½	80	175	2	40	40	Heavy.
Perche Placer Mine‡	Hydraulic	2 No. 2	11 to 22	3,000	5	6	......	2½	160	1,152	3	60 and 65	12 to 35	Light.
Markerson Mine§	Hydraulic	1 No. 2	14	900	4	6	......	2	320	250	2	......	......	......
Uscillina Mine	Hydraulic	1 No. 2	12 to 14	......	2	6	......	......	200	200	3	60	12	Light.
Nelson Mine	Hydraulic	1 No. 2	14 to 16	700	5	7	100	......	200	150	......	40	12	Heavy.

Note.—Sixteen hydraulic claims in operation, employing eighty-seven (87) men.

* From 1875 to 1883 the mine yielded $147,733 17.

† Altitude, 475 to 1,118 feet. Yield for season, 27½ cents per cubic yard; average, new shaft, 67 cents per cubic yard.

‡ Altitude, river, 481 feet; mine, 1,200 feet.

§ Three thousand five hundred dollars per season.

INYO COUNTY.

By W. A. GOODYEAR, Geologist, Assistant in the Field.

For something over two years, *i. e.*, from April, 1870, until July, 1872, I was constantly and actively employed on the old State Geological Survey of California, under Prof. J. D. Whitney, at that time State Geologist. But, owing to the discontinuance of the Geological Survey, which followed shortly afterwards, a greater portion of the geological work done in those two years has never yet been published. I have now, therefore, as the sequel will show, drawn freely and extensively from my old notes—more especially with reference to San Diego and Inyo Counties, but to some extent also concerning San Bernardino, Los Angeles, Kern, and Tulare Counties.

The little town of Keeler, on the eastern shore of Owens Lake, is at the present time (1888) the southern terminus of the Carson and Colorado Narrow Gauge Railroad, and south of the town of Belleville, in Nevada. This railroad now runs only three passenger trains each way per week.

The most southeasterly point visited in Inyo County, during the past summer, was the town and vicinity of Darwin, about twenty-three and one half miles by stage road southerly from Keeler.

Some intermediate distances, as measured by odometer, are here given, as follows:

Keeler to Stone Corral, No. 1	3.60 miles.
Stone Corral, No. 1, to summit of Rolling Hills	5.00 miles.
Summit of Rolling Hills to Stone Corral, No. 2	3.34 miles.
Stone Corral, No. 2, to Coso Station	3.18 miles.
Coso Station to Darwin	8.46 miles.
Total	23.58 miles.

Starting from Keeler towards Darwin, nothing is seen along the road except the ordinary "wash" from the metamorphic and granitoid rocks, which form the great bulk of Inyo Range of mountains, until we reach the vicinity of the Stone Corral, No. 1. But about there we strike a broad belt of basaltic bowlders, which have been washed out from the comparatively low hills lying south of Cerro Gordo and east of the lake. After crossing this belt, the pebbles and bowlders are again, for a mile or two, chiefly metamorphic. Then we strike volcanic rocks again, and from there on, along the road to Darwin everything is volcanic, and mainly basaltic, as far as Coso Station. But at the latter place we find the granite, which constitutes nearly all the southeastern part of the Coso Range of mountains, and then continues to form the greatest portion of the country far beyond Darwin towards the east.

The altitude of the town of Darwin is not far from five thousand five hundred feet above the sea.

The Defiance Mine is situated about one mile northerly from Darwin, and some five hundred feet higher. The ores from this mine are chiefly galena, with carbonate and sulphate of lead, and some pyrites, and run from twenty-five to two hundred and fifty ounces of silver, and from $20 to $75, or more, in gold, per ton.

The mine seems to consist of a series of irregular chambers, forming, in a broad sense of the term, a sort of contact deposit between the granite on

the northeast, and a heavy body of calciferous quartzite, which forms the mass of the hill to the southwest. There are also some beds of tolerably pure limestone. The granite is generally rather fine grained, but varies much in character. Some of it is very micaceous, while some of it contains but very little mica. The surface outline of the edge of the granite is also extremely crooked and irregular; and the overlying quartzites and limestones on the southwest, though generally striking northwesterly and dipping southwesterly, have nevertheless in some places been much disturbed. The ore chambers often contain large bodies of oxide of iron, and also of crystallized calcite; while through the adjacent granite and quartzite, there are disseminated large quantities of iron pyrites, which latter mineral seems to carry most of the gold. Free gold is here very rarely visible to the naked eye, though a few small specimens have been found. Almost all the quartzite in the region contains more or less lime.

A tunnel has been driven some distance at the Defiance, in a direction about south, 70 degrees west, magnetic, and a slope with nearly the same course and a pitch of about 35 degrees has been sunk about three hundred and eighty feet. But little ore has yet been found, however, below the one hundred and eighty-foot level.

It has been believed by those interested in the mine that there are three separate veins here, which curve around the southwestern side of a conoidal surface of the granite. But the fact is that the workings are extremely irregular in shape, and no well defined vein is visible.

The mine has produced largely in the past, and may possibly do so again at any moment in the future, for its ores are rich. But it is essentially a "pockety mine," and a blind and risky one to work. About two miles north of the Defiance Mine is the Lucky Jim, now owned by Mr. J. A. McKenzie.

This mine is on a vein in the siliceous limestones, which strikes about northeast, magnetic. A considerable body of rather fine grained, blocky granite, containing magnetic iron and epidote, and with very irregular outlines, lies just west and northwest of the mine. West of the granite, the whole mass of the hill, so far as seen, appears to be calciferous quartzite, generally dipping southwesterly. This mine was formerly owned by the New Coso Mining Company. The vein dips about 80 degrees to the northwest. A vertical shaft was sunk three hundred and twenty-six feet deep, and was provided with a hoisting engine and safety-cage. Below the bottom of this shaft the mine has been worked by winzes to an additional depth of one hundred and seventy-four feet. The principal ore shoot extended about four hundred feet along the vein, and to a depth of two hundred and fifty to three hundred feet. The total length of the workings along the vein is some one thousand two hundred feet, and a little ore has been taken out in spots for the whole distance. The ore was chiefly oxidized ores of lead, with some silver, but little or no gold. There is some galena here, but its quantity is not large; and there is far less crystallized calcite here than at the Defiance, and also much less iron pyrites; though there is some of both. It will not now pay to ship, and probably the time has never yet been when it would pay to work ores from here which would yield much less than $50 per ton.

Mr. McKenzie thinks this mine has turned out an aggregate of between $1,250,000 and $1,500,000; but that on the whole more money was expended here than was ever taken out, which seems not improbable.

There are, in the immediate vicinity, several other nearly parallel veins and spurs, which have been worked to some extent, and from which small bodies of rich ore have been taken.

The old Christmas Gift Mine, about half a mile south of the Lucky Jim, close to Mr. McKenzie's house, and now also owned and worked by him, is another mine precisely similar in its general character to the Lucky Jim, and strikes and dips in about the same directions. It is now about two hundred and fifty feet deep, and has been worked, and ore found in paying quantities for a distance of three hundred feet along the vein.

A short distance north of the Defiance are the Kerso and Independence Mines. At the Kerso a straight tunnel runs about five hundred feet north, 87 degrees west, magnetic, through the granite before it strikes the limestone. Some drifting has been done in the limestone, and some good silver-lead ore taken out. Also, immediately adjoining the granite, some good gold ore has been extracted.

At the Independence Mine a considerable quantity of moderately fair silver-lead ore is in sight, consisting chiefly of carbonates, but with some galena.

About a mile northeast of Darwin is the Copper Grand Mine, where some twenty or thirty tons of fair copper ore have been extracted, and some five or six tons shipped. The ore is a mixture of carbonates and sulphurets, and occurs in the limestone on the east side of, and near the granite.

Most of the country rock to the west of the Defiance, Independence, Kerso, and Lucky Jim Mines is quartzite, more or less calciferous, though there is some very pure limestone intermixed with it. At the Defiance Mine the rock is much broken and shattered, and handsome crystallizations of dogtooth spar are found.

Three smelting furnaces were built at Darwin about the years 1875 to 1877. They were as follows: The Cuervo furnace, with a capacity stated at twenty tons per day; the Defiance furnace, with a capacity stated at sixty tons per day; and the New Coso, with a capacity stated at one hundred tons per day. All these works are idle now. The last run was made at the Defiance furnace in 1885.

Very little work was being done at any of these mines about Darwin when visited in July, 1888. At the Lucky Jim nothing was doing; at the Christmas Gift three or four men were working; at the Defiance, two. More or less prospecting was going on at many localities, and a few sacks, or tons, of rich ore were being shipped from time to time; but there was no mining of any importance.

A similar state of affairs was said to exist at the Panamint District, sixty miles further southeast, towards Death Valley, and also in the Lookout District, some fifteen or twenty miles easterly from Darwin, which districts were therefore not now visited.

About two miles west of Darwin there are two or three little isolated basaltic outbreaks in the granite, and the tops of the hills immediately south of Coso Station are also volcanic.

Back of the hotel at Keeler, and within seventy-five feet of the shore of Owens Lake, there is a pretty strong spring of water containing some sulphur, but very little alkaline salts. It is not long since this spring was covered by the lake, which has now been falling for a number of years, and is three or four feet lower than it was three or four years ago.

There are in the waters of this lake great quantities of some green, slimy, vegetable organisms of some low order, one of which forms small globules or spheres about the size of a large pea, say one fourth of an inch in diameter. There are also several different species of flies which swarm around the lake, and one small species, in particular, which in many places literally blackens the shores with its myriads. There are also in the waters

of this lake myriads of a small larva, from one eighth to one fourth of an inch in length, with many legs and two very black eyes, which somewhat resembles the larva or "wiggler" of the ordinary mosquito, and which I take to be the larva of the small, and most multitudinous, fly above mentioned. It is the same species that I saw twenty-three years ago, *i. e.*, in 1865, in the water of Mono Lake, which latter is in many respects a counterpart of Owens Lake. I do not know whether it has ever been described. If not, the cause must lie either in the fact that no competent entomologist has ever yet visited these lakes, or else in the fact that (as the writer well knows), when the water is bottled up, these organisms quickly die. One thing I noticed for the first time on this visit, viz.: Each one of these larvæ is inclosed in an almost transparent sack of thin, gelatinous matter. How he makes his way through the water inside of this sack is more than the writer can tell; but he does it, and goes where he pleases. As to the white worms which also exist by millions in both these lakes, and which by some sort of sticky excretion form sandy cases or coatings for themselves, and which, when washed ashore in masses by the surf, the Indians used to gather, and after drying them and rubbing off their coats, use them for food, I do not know whether they are an intermediate state of the insect between the above mentioned larva and the fly, or what they are. The fact remains that they exist.

Strange as it may seem that a lake, whose waters have the composition which those of Owens Lake have, should support life of any kind, it is nevertheless true, not only that those waters are full of life, but also that the decay of such life, when washed up on the shores by the surf, and thus left exposed to the sun, often taints the air by its stench for miles around. The writer was once nearly suffocated by sulphurous acid gas from the volcano of San Miguel in the Republic of San Salvador, Central America, and he has seen many noxious exhalations, but he never yet encountered any natural exhalation which was quite so disgusting and sickening as a breeze which he once met from Owens Lake. No ordinary fish can live in either of these lakes. There are fish in Owens River, and in some of the other fresh water streams coming into the lakes. But whenever these find their way down into the lakes themselves, they quickly die, and are washed ashore.

About one mile north of Keeler, and on the shore of the lake, are the chief works of the Inyo Development Company (C. F. Allen, Superintendent), who are engaged in manufacturing carbonate of soda from the waters of the lake. They have here about fifteen acres of ground covered with evaporating vats, made by plowing, and then carefully leveling, and afterwards heavily rolling the clayey ground, so as to make it water-tight. The water of the lake on July 18, 1888, registered 9 degrees Baumé, corresponding to a specific gravity of about 1.063. Two or three months earlier it was 7½ degrees Baumé, corresponding to a specific gravity of about 1.052. The salts which it contains are chiefly chloride of sodium (common salt), and the monocarbonate, bicarbonate, and sulphate of soda.

According to Mr. Allen, there is at a low temperature, little difference in the solubility of all these salts. But, at a higher temperature, the monocarbonate and the bicarbonate will crystallize out together in the shape of a definite chemical combination with its own form of crystallization, while nearly all the chloride and sulphate yet remain in solution.

And therefore their "cold weather soda" is a compound of all the salts, while their "hot weather soda" is a nearly pure combination of the two carbonates with very little of either the sulphate or the chloride.

The crystallization takes place, at a proper temperature, at from 30 degrees to 35 degrees Baumé, corresponding to a specific gravity of from 1.245 to 1.299. The substance thus crystallized out at this stage is, as above stated, according to Mr. Allen, a definite chemical compound of the two carbonates of soda, which has its own peculiar form of crystallization. He further states that it appears that this peculiar combination of the two carbonates of soda will only crystallize in this way, *in the presence of the chloride and the sulphate*, inasmuch as, if it be dissolved in pure water, it cannot then be made to recrystallize in the same form, but will be decomposed, and the monocarbonate and the bicarbonate will then crystallize separately in different forms. On this principle they were (July 18, 1888) about to erect works for the re-solution, recrystallization, and thus the separation of the two carbonates. They produced about four hundred tons of the crude product of 1887, and they expected to produce about one thousand five hundred tons in 1888.

The water of the lake is lifted ten or twelve feet to the highest vats by a new windmill, said to be capable of lifting seventy-five thousand gallons per hour, when the wind blows with a suitable velocity. The mother liquor, containing chiefly the chloride and the sulphate of soda, is returned to the lake.

In the nasty and sickening stink which sometimes arises from the waters of that lake, I suspected that there might be a noticeable quantity of sulphur; but a half dollar left lying in the water over night was not perceptibly blackened.

On July nineteenth, I again visited Cerro Gordo, which, though once a most flourishing town, with the richest mines that Inyo County has ever yet produced, is now, as emphatically as either Darwin or Panamint, a deserted town.

It is about eight or nine years now since all smelting operations ceased here. The Union Mine is under lease to Thomas Boland and John S. Gorman, who are extracting small quantities of ore, which they ship by rail to Selby's Smelting Works at San Francisco. The new shaft at this mine was sunk nine hundred feet; and from the seven hundred-foot level they drifted some five hundred or six hundred feet easterly, in order to strike the continuation of the large ore bodies previously found there, at a depth of about one hundred and sixty-five feet below the older workings; but they did not find them. They did find some small streaks and bunches of good ore, but nothing of much importânce, neither in this drift nor in the shaft below this level. Mr. Wm. Crapo (who is a surveyor), however, asserts that in the bottom of the old mine the ore bodies were dipping easterly some 45 or 50 degrees, and that on the seven hundred-foot level they did not drift far enough to the east by something like one hundred and fifty or one hundred and sixty feet, in order to reach the place where the large ore bodies ought to have been found at this level. Be that as it may, it seems somewhat strange that this mine, which has probably produced $2,000,000 or $3,000,000, should have been abandoned as it was, without far more prospecting work having been done. Even now it is a promising field for the use of the diamond drill, and the time may yet come when it will revive. At the present time, there is altogether, perhaps, thirty or forty men around the site of the old town, getting their living as best they can. Amongst them, Mr. Crapo is working at his mine, on a very heavy quartz vein, on the south side, and near the top of Buena Vista Peak.

For several miles to the south of Keeler, close along the eastern shore of the lake, there are numerous springs of drinkable water, which, however, contains a little sulphur and a little alkali. All of them are cold.

The Inyo Marble Quarries are situated at the very foot of the Inyo mountains, about five miles northerly from Keeler, and seven and a half miles southeasterly from the railroad station of Lone Pine. The dolomite from these quarries is generally fine grained and quite hard, takes a good polish, and is a durable and handsome stone. The quarry, however, is full of seams and cracks, which run in all directions, and it is difficult to get out blocks which are perfectly sound, of more than two or three tons in weight. Basaltic dikes, here and there, cut through the limestone in this vicinity.

Within the limits of Inyo County are contained the highest and, perhaps, also the lowest, ground in the United States south of Alaska. Mount Whitney there towers to a height of between fourteen thousand five hundred and fifteen thousand feet above the sea, while seventy-five or eighty miles in an air line southeast of it lies Death Valley, which is below the sea. If any reliable determination has ever been made of the maximum depth of Death Valley below the level of the sea, the present writer is unaware of it. Mr. Hanks, in the third annual report of the State Mineralogist, 1883, page 31, states it to be one hundred and ten feet; but he does not give his authority for these figures, and the depth has generally been supposed to be considerably more than that. If, however, this be correct, then Death Valley is not so low by nearly two hundred feet as are some points in the Colorado Desert, in San Diego County, northwest of Fort Yuma. Concerning the latter, a recent letter from Colonel George E. Gray, formerly Chief Engineer of the Southern Pacific Railroad Company, speaks as follows: "I have not the exact data relating to the Colorado Desert Sink. The grade of the Southern Pacific Railroad opposite Dos Palmos is, if I remember aright, two hundred and sixty-seven and one half feet below the level of the ocean. This is not the lowest part of the sink. Our levels gave over twenty feet lower in some places; but there may be other places to the southwest still lower."

The altitude of Mount Whitney has never yet been very accurately measured. It has only been determined by means of the barometer, which, at the best, at such altitudes, is liable to rather large errors. The first measurement ever made of its altitude was reported by the writer in an article read before the California Academy of Sciences, October 6, 1873. The result there given was fourteen thousand eight hundred and ninety-eight and one half feet, which was carefully computed from observations taken on top of the mountain, with a first rate Green's mercurial barometer, in perfect order, by Carl Rabe, an experienced and skillful barometric observer, on September 6, 1873.

The next measurement was made by Clarence King, who, a few days later, in September, 1873, climbed the mountain, and who, in his "Mountaineering in the Sierra Nevada," fifth edition, 1875, page 297, asserts its altitude to be fourteen thousand eight hundred and eighty-seven feet. It may be noticed, in passing, that these two results are rather surprisingly close together for *barometric* determinations of such altitudes. The last measurement, so far as the writer knows, which is entitled to particular notice, was made a few years ago by Professor Langley, who reports the altitude at fourteen thousand five hundred and twenty-two feet.

The following article, written by me, and published in the "Inyo Independent" of August 4, 1888, is here inserted, with a few corrections:

"HISTORY OF MOUNT WHITNEY.

"*Editor Independent:*

"SIR: Inasmuch as a mistake was made in 1870 concerning the identity of Mount Whitney, and inasmuch as after the discovery of that mistake in 1873 a cool, deliberate, persistent, and determined effort was made by certain parties in Owens Valley to change the name of Mount Whitney and call it 'Fisherman's Peak,' it occurs to the present writer that a history of that business by one who is familiar with most of its details from beginning to end may prove of some interest to your readers, not only here in Inyo County, but also wherever your valuable paper may circulate in other parts of the country.

"Mount Whitney was recognized as the highest peak in the State of California (and, so far as yet known, it is the highest peak in the United States south of Alaska), in 1864, and was then so named in honor of Professor J. D. Whitney, who was at that time State Geologist in California.

"The discovery party consisted of Professor William H. Brewer, Geologist in charge; Charles F. Hoffmann, Topographer, and Clarence King, Assistant Geologist.

"This party came into the mountains from the western side, *i. e.*, from the Tulare Valley. They ascended several of the high peaks in the vicinity of Mount Whitney, and gave names to quite a number of them, among which are Mount Brewer, Mount Williamson, Mount Tyndall, Mount Whitney itself, and the 'Sheep Mountain.'

"A little later, in July, 1864, Clarence King made a resolute but unsuccessful attempt to climb Mount Whitney, and really succeeded in reaching a point on the mountain only some two hundred or three hundred feet below the summit, when he was stopped by a ledge of rocks, up which he could not climb, though subsequent explorers state that one may safely go *down* over the same ledge.

"A complete account of this trip will be found in the 'Geology of California,' Vol. I, published by Professor Whitney in the following year, viz.: 1865. Furthermore, accompanying this account in the same volume there is a description of Mount Whitney and its surroundings, which is sufficiently full and accurate to prevent all possibility of mistake in identifying the peak by any one who has first carefully read that description and afterwards gets on top of any of the high peaks in the near vicinity when the air is clear, so that he gets a good view of the region. But little was heard or known of Mount Whitney, however, in Owens Valley, until 1870 or 1871.

"In 1870 another party of the State Geological Survey, still under Professor Whitney, went up the Tulare Valley, crossed the mountains through Walker's Pass, and spent two or three months in Owens Valley and the Inyo and White Mountain Ranges. That party consisted of Charles F. Hoffmann, Topographer in charge, Alfred Craven, Assistant Topographer, and the present writer as Geologist. That was the time when the mistake was first made in the identity of Mount Whitney. It was a very natural mistake. For 'Sheep Mountain,' which lies some five or six miles southeast of Mount Whitney, and about opposite the upper end of Owens Lake, really lacks but a few hundred feet of being as high as Whitney, while it stands several miles nearer to the eastern foot of the range, so that looking up from the valley, ten thousand feet below these summits, the 'Sheep Mountain' *looked* the highest, and at the same time its *shape* bears a close resemblance to that of Mount Whitney itself as seen from the valley near the lake.

"Mr. Hoffmann, therefore (who was the only one in our party who had ever seen Mount Whitney before), mistook the 'Sheep Mountain' for Mount Whitney, and we continued to call it so all that summer. But after our return to San Francisco, when Mr. Hoffmann came to plot his work, he found a large and unaccountable discrepancy in the location of Mount Whitney between his work of 1864 and 1870, the latter work placing Mount Whitney five or six miles further southeast than the former. He was sure that his work of 1870 was correct; for the bearings taken by him that summer from various points in the valley and in the Inyo Mountains, were numerous and agreed well with each other. But in 1864 he had only two bearings by means of which to locate Mount Whitney: One of these was taken by himself with a transit instrument from the top of Mount Brewer, and on that bearing he felt that he could rely. But the other one was a bearing taken by Mr. King with only a pocket compass, from the top of Mount Tyndall, and this bearing, he concluded, must have been erroneous. And thus the mistake remained undiscovered.

"In 1871 Mr. King determined to make another effort to reach the summit of Mount Whitney, this time from the eastern side. So, having obtained from Mr. Hoffmann a full description of the situation and appearance of the supposed Mount Whitney as viewed from Owens Valley, he came to Lone Pine, and without any difficulty succeeded in reaching the summit of 'Sheep Mountain,' and getting observations of its altitude, still supposing it to be Mount Whitney. The reason he did not discover the mistake was that there were clouds on the mountains at the time of his ascent, which prevented his seeing the true peak. He shortly afterward published an account of this ascent in the first edition of his 'Mountaineering in the Sierra Nevada.'

"So it was not until July 27, 1873, when Mr. M. W. Belshaw and myself rode our mules to the very top of 'Sheep Mountain' that the mistake made three years before, concerning Mount Whitney, was discovered. It happened to be clear weather when we climbed the mountain, and therefore the instant we reached the summit, we saw five or six miles northwest of us the tremendous crags of Whitney itself, the main peak evidently and unmistakably rising considerably higher than the one on which we stood.

"Up to that time there is, so far as I know, or have ever been able to learn, no reliable record or evidence to prove that any human being had ever set foot upon the summit of Mount Whitney.

"It was, however, but a very short time after Mr. Belshaw and I returned to the valley and reported the error we had discovered before several parties succeeded, one after the other, in reaching the summit of the mountain; and I believe some rather acrimonious disputes afterwards arose between some of the parties as to which of them was really entitled to the credit of being the first to get there. But into the merits of these disputes I have no wish to enter. I do wish, however, to add a few words concerning the discreditable 'Fisherman's Peak' affair.

"It appears that when Professor Whitney was in Owens Valley himself in 1872 for the purpose of studying the effects of the great earthquake of March twenty-sixth of that year, he became quite unpopular with a good many people in the valley, some of whom took a very strong personal dislike for him. When, therefore, a year later it was suddenly discovered that a lower mountain had for three years been called Mount Whitney by mistake, some of these people thought it would be a fine opportunity for revenge upon the man whom they disliked, by making his name stick to the lower peak forever and calling the highest one something else. There-

fore they dubbed Mount Whitney 'Fisherman's Peak,' and tried hard and long to make that name stick. But it will not stick.

"Mount Whitney was named, and almost climbed, by Clarence King, in 1864, and was well described in 1865. It is the highest mountain in the country, and Mount Whitney it will remain. The 'Sheep Mountain' was also named by King in 1864, and that name will adhere to it. The other high peaks in that neighborhood have names given to them many years ago, so that there is no place nor habitation in those mountains for any such name as 'Fisherman's Peak'—which will doubtless fall into the utter oblivion which it deserves.

"Respectfully yours,

"W. A. Goodyear.

"Independence, July 30, 1888."

A tremendous range of sharp, granite needle peaks extends for a mile or two southwest from Mount Whitney. Still further southeast, and only a short distance north of the Sheep Mountain, is another range of similar peaks, which, though not quite so high as some of those near Mount Whitney, is, from its situation, a far more prominent object of view from many points in Owens Valley than even Mount Whitney itself. This range has been well enough named the Saw Teeth.

There is, furthermore, another peak, which, though considerably lower than either Mount Whitney or the Sheep Mountain, is yet very high, and stands at the very eastern front of the mountain range, so that, as seen from Lone Pine, it is as prominent an object as any of the others. Its shape also, as viewed from that point, bears a very close resemblance to that of the Sheep Mountain, and also to that of Mount Whitney itself, as seen from the northern shore of Owens Lake, a few miles further southeast. This mountain has been called Lone Pine Peak.

The following magnetic bearing, taken July 27, 1888, from the village of Lone Pine, will enable any one who goes there to identify several of these peaks:

The Sheep Mountain bears	S. 44° W.
Highest peak of Saw Teeth bears	S. 50° W.
Lone Pine Peak bears	S. 55° W.
Mount Whitney bears	S. 65° W.
Another very high peak bears	S. 68° W.
Mount Tyndall bears	S. 87° W.
Mount Williamson bears	S. 89½° W.

Between one third and one half mile east of the road from Lone Pine to Independence, at a point about six miles from Lone Pine, and perhaps one half mile west of Owens river, on Mr. Robertson's place, in the region that is called Georges Creek, there is an artesian well said to be two hundred and eighty feet deep, which flows something like half a miner's inch of good water. This is, so far as the writer knows, the only artesian well now existing in Owens Valley; though some borings have been made at Lone Pine, and one well is said to have been sunk two hundred feet there without success.

On July 31, 1888, the writer went with John Welch, as guide, to his camp in the Old Kearsarge Mining District, on the eastern slope of the Sierra Nevada, about eight miles from the town of Independence, and at an altitude some five thousand feet higher, or a little over ten thousand feet above the sea. The Kearsarge District is now almost utterly abandoned, and Mr. Welch's business up there at this time of the year consisted in the packing of consolidated snow from old banks, which remain to a greater

or less extent all summer long around some of the higher peaks in this vicinity, down to the town of Independence. He takes five pack mules at a time, and loads them with about two hundred pounds each, so that on each round trip, of which he makes three per week, he brings into town about half a ton of this snow.

The country about Kearsarge is almost exclusively granite, and the granitic sand is everywhere full of magnetic iron. The granite varies largely in character; some of it is syenitic, while some of it is very feldspathic, and occasionally it graduates into a "blocky" felsite. It generally contains some magnetic iron, as well as hornblende, and epidote is not uncommon. The Kearsarge Mountain, though not so high as many other peaks in this region, is, nevertheless, a very high mountain. It stands in the very eastern edge of the great mass of the Sierra, looking directly down upon Owens Valley, from the western edge of which it rises very abruptly some nine thousand feet or more, its summit being not far from thirteen thousand feet above the sea. A number of quartz veins run through various parts of this mountain, generally striking from N. 10 degrees E., to N. 20 degrees E., magnetic, and dipping very steeply to the west, being sometimes almost vertical.

In the early days of the mines here, some of these veins yielded considerable quantities of ore, which was very rich in both gold and silver. One lot of ten tons of ore is said to have yielded $900 per ton. There was also for some years quite a busy town here, and at various points along the creek three quartz mills were running—one with ten stamps, one with five, and one with four. But the town has now entirely disappeared, and but little is left of any of the mills; while the mines are all of them abandoned and idle, with the single exception that one man, a Mr. Ward, is still working alone at a mine owned by him on the eastern slope of the mountain, where the aneroid barometer reads about ten thousand feet above the sea. Most of the ores from here contained but little sulphurets, and were worked in the mills near by; the charges for custom milling at that time being $50 per ton. Occasionally, however, some very rich silver-lead ores were found, which were shipped away.

The Beveridge District, lying in the eastern part of the Inyo Range of mountains, and north of New York Butte, was not visited, but the writer was informed that some half dozen men were still at work there in the Key West Mine.

Scattered at intervals for a distance of fifty or sixty miles in a northwest and southeast direction, along the southwestern slopes of the Inyo and White Mountain Range on the east of Owens Valley, is a string of mines, whose history up to the present time has not been fortunate, and which were not visited on this trip. Some of these mines were first opened to some extent very early in the sixties. Many of them have yielded small quantities of very rich ore, but none of them have ever yet been very extensively worked. A few of them were visited in 1870, and some remarks concerning these will be found in the writer's notes of that date. At the present time, at several of these localities, there are from two to four or five men at work, but the aggregate amount of ore extracted is very small.

Mount Whitney is not visible from the town of Independence, being hidden by a little peak to the left of Mount Williamson, which peak bears south 5¼ degrees west, magnetic, from Independence. But in the valley, one or two miles east of Independence, Mount Whitney begins to open out, and it is in plain sight from the railroad station on the east side of the

river; the station itself being within one hundred yards of the site of the old and long since ruined town of Bend City.

From Independence to Big Pine, following the stage road west of the river, on August fourth, the following odometer distances were obtained:

Independence to Black Rock Springs	9.60 miles.
Black Rock Springs to Conklin's Ranch	5.12 miles.
Conklin's Ranch to Fish Spring Arrastras	4.74 miles.
Fish Spring Arrastras to Fish Spring	2.59 miles.
Fish Spring to Big Pine	5.23 miles.
Total	27.28 miles.

The Black Rock Springs make their appearance from beneath a mass of black basaltic lava, just a little to the north of the southern limits of the extensive, but local volcanic outbursts which cover many square miles of this portion of the valley. They consist of a cluster of springs scattered over an acre or two of ground, and, in the aggregate, furnish a stream of good water, which was judged equivalent to a stream four feet wide, and one and one half feet deep, with a velocity of three and one half miles per hour. They are the most copious springs anywhere in Owens Valley; though there are others of somewhat similar character and much larger, in the mountains far to the northwest, in Mono County, about the headwaters of Owens River. The soldiers stationed at Camp Independence once tried to dam these springs in order to utilize the water to better advantage. But the attempt was a failure; for, though the configuration of the surface of the ground was favorable enough for the building of a dam, yet, when the dam was built, and inside of it the water began to rise, it presently found its way out through the cavernous lava beneath the dam.

The Fish Springs also come out from under the lava, are perfectly similar in general character and origin, and furnish a considerable volume of good water, though not so much as the Black Rock Springs do. These waters are evidently nothing else than a portion of the drainage of the adjacent eastern granite slopes of the high Sierra on the west, which, on reaching the upper edge of these volcanic formations, sinks, and after finding its way for several miles underground, through or beneath them, at last makes its appearance again from beneath the lower edges of the lava in the valley in the form of these springs.

From Black Rock Springs to within two miles or so of Big Pine the road runs almost all the way over volcanic materials. But at Fish Spring Arrastras, a little to the north of Red Mountain, and a little southeast of the highest and most prominent volcanic cone of the region (which cone, by the way, if not yet named, may as well be called Fish Spring Volcano), a small granite hill sticks its head up through the volcanic matter. And in this hill they have found one or two small veins of rich gold-bearing quartz filled with sulphurets. Mr. Jas. McCarthy is working some of these ores in arrastras, the tailings from which he concentrates in sluice boxes, so as to save the pyrites for shipment and treatment elsewhere, as these sulphurets are said to be very rich in gold.

On August sixth the writer climbed to the highest crest of the Fish Spring Volcano, which he found to be about two thousand feet higher than the village of Big Pine. It is a very prominent cone, visible from points nearly fifty miles away in some directions, and its top is about as high as any of the volcanic formations that here extend up the flanks, either of the Sierra Nevada on the western, or of the Inyo Range on the eastern side of the valley. It has two craters; one of them several hundred feet in diameter, and now probably one hundred to one hundred and fifty feet deep in

its very summit; and the other one of smaller dimensions, but still well marked, and situated somewhat lower down on its side. To the northwest of the volcano, several small knobs and ridges of granite project up through the lava-flows, which surround them as well as the volcano itself on all sides. There are quite a number of other crater-cones within a radius of six or eight miles from here, but this one is by far the most prominent landmark of all of them, and is well entitled *par excellence* to the name of the Fish Spring Volcano.

Beginning on August eighth, a five days' trip was made from Big Pine across the Inyo Range of mountains into Deep Spring Valley and the surrounding region. The following odometer distances were noted:

On the Way Over.

Big Pine to Ashmore's	7.590 miles.
Ashmore's to Summit	4.085 miles.
Summit to Antelope	5.165 miles.
Total	16.840 miles.

On the Return.

Antelope to Summit	8.075 miles.
Summit to Ashmore's	3.625 miles.
Ashmore's to Big Pine	7.345 miles.
Total	19.045 miles.

It will be at once noticed that there are in this case large discrepancies between the odometer distances in traveling in opposite directions over the same road; and the figures are here given as above, for the purpose of illustrating how unreliable the pendulum odometer is under some circumstances. The wagon road here followed is a good and tolerable smooth one all the way across the mountains; but the descent on the eastern side, from the Summit to Antelope, is, much of the way, considerably steeper, and also somewhat rougher, than the slope on the western side of the range. Ashmore's is about half way up the western slope of the range, and the following are some approximate altitudes above the sea, as given by the aneroid barometer:

Big Pine	4,300 feet.
Ashmore's	6,160 feet.
Summit	7,450 feet.
Antelope	5,880 feet.

We also, on this trip, had a good team, and made good time, especially in going down hill, and more especially as we drove very rapidly some of the way down the eastern slope of the mountains on going over. Now, referring to the distances once more, it will be seen that in every instance the odometer recorded a less distance in going down hill than in going up hill, and, furthermore, that the greatest discrepancy of all occurred where we drove fastest down hill. It might be supposed that the application of the brake might account for some of this; but it would be absurd to suppose that it could account for the difference between 5.165 and 8.075 miles, unless, indeed, the wheels were absolutely locked, which was not the case; and, in fact, the brake was very little used at all. The trouble is inherent in the nature of such an odometer itself, as the instrument was in perfect order. The uphill distances are probably correct, for such an instrument cannot record a greater distance than is actually traveled, though it may record a great deal less. If it had been possible to have attached the odometer to the wheel in such a way that the axis, from which the pendu-

lum swings, should have been in line with the central axis of the hub itself, the instrument would probably have recorded the distances correctly, no matter how fast the driving. But the only means of securely attaching such an odometer to the wheel is by strapping it to the spokes outside the hub. The result is that, with every little revolution of the wheel, the odometer itself, pendulum and all, also describes a small circle, of probably not less than eighteen inches in diameter, around the axle, and as the speed increases, the centrifugal force thus generated, becomes at last great enough to throw the heavy pendulum over its own axis of suspension with each revolution of the wheel, and then it does not record at all.

Antelope is at the foot of the mountains, on the northwest side of Deep Spring Valley, where there is a spring of good water. It is just at the upper edge of the sagebrush slope, and is some six hundred or seven hundred feet higher than our camp of June 10, 1870, which was close to the foot of the mountains on the southeast side of the lake, and which bears from here south 50½ degrees east, magnetic, distant in an airline about five miles. All the lower portion of the mountains immediately to the north and northwest of Antelope consists of very hard, metamorphic, "blocky," and nearly black sandstone and shales, which inexperienced people might take for volcanic rocks. Higher up comes a broad belt of calciferous quartzite, much of which is very white, and most of it fine grained, with saccharoid texture. Still higher, the crests of the mountains are a tolerably fine grained granite. Through the quartzite, about three miles north from Antelope, and ranging from one thousand one hundred to one thousand four hundred feet above it, there runs for a considerable distance in a nearly north and south direction, a vein of oxides and sulphurets of iron which, in places, carries some rich ores of bismuth, chiefly carbonates. This vein dips very steeply to the west, and is very irregular in thickness, the maximum thickness now visible being some four or five feet, while in other places it seems to run out almost entirely. It could be attacked at a depth of several hundred feet by tunnels.

Some two and a half miles, a little west of north from Antelope, and one thousand two hundred to one thousand three hundred feet above it, is the Gibraltar Mine. It is in the quartzite, which is here generally very hard and very fine grained. There are many small seams here running in many directions, most of which contain a little ore; but the chief one is a seam striking about north 70 degrees east magnetic, and dipping very steeply to the northwest. This seam has sometimes three or four feet in thickness of good ore, though in other places it also runs out almost entirely. It has been traced for some two thousand feet or more. The owner states that the ore hitherto shipped from this mine has yielded an average of about $80 per ton in gold and silver, while small selected lots will yield $200 or more per ton.

The major axis of Deep Spring Valley lies in a direction about north 10 degrees east magnetic. The valley is not far from twelve miles long, and its maximum width is, perhaps, six miles. It is well shown on the southeastern quarter of the yet unfinished topographical "Map of Central California," commenced a good many years ago by Professor Whitney. Some two miles northeast of Antelope is the mouth of Deer Creek, which comes into the valley from the northwest.

Northeast of Deer Creek the granite comes down to the foot of the mountains, which there continue to be granite almost all the way to the northeast end of the valley. Two or three miles northeast of Deer Creek is the mouth of Wymans Creek, which also comes in from the northwest, and is the largest of all the streams coming into the valley. It furnishes the water for Gil-

bert's ranch, which lies on the southeast side of the upper or northeast portion of the valley, about five miles easterly from Antelope.

From a point not more than a mile east of our camp of June 10, 1870, and a little distance southwest of Crocker's present ranch, the rocks in the mountains on the southeast side of the valley are nearly all granite up to the northeast end of the valley. But immediately at and around the northeast end, or head, of the valley there are several small and isolated outbreaks of black basalt, which has here burst its way up through the granite, the lava covering an aggregate area of perhaps two or three square miles.

The mine of Messrs. Greenly & Broder is situated high up in the mountains, just northwest of the head of Deep Spring Valley, and distant by crooked wagon road about eight miles from Gilbert's ranch. The odometer here played the same trick as the one described and explained above, recording about eight miles in slowly climbing up the mountains, and only about five miles in driving rapidly down.

Close to Greenly & Broder's mine is a granite peak, which, according to the readings of the aneroid barometer, is some two hundred and thirty-five feet higher than their house at the mine, and something over seven thousand seven hundred feet above the sea. This peak was climbed, and from its summit the following magnetic bearings were taken:

Head (*i. e.*, northeast end) of Deep Spring Valley	S. 48½° E.
Telescope Peak (a very high peak near Panamint)	S. 23° E.
Gilbert's ranch	S. 15° E.
Cerro Gordo Peak (?)	S. 14½° E.
Waucoba Mountain (which hides Mount Hahn)	S. 12° E.
Saw Teeth (in Sierra Nevada, just north of Sheep Mountain)	S. ½° E.
Camp of June 10, 1870	S. 1½° W.
Mount Whitney	S. 2° W.
Mount Williamson	S. 4 ° W.
Antelope (in Deep Spring Valley) about	S. 20½° W.
High, helmet-shaped peak in Sierra Nevada	S. 36° W.
High, sharp, snowy peak in White Mountains	N. 62° W.
Greenly & Broder's mine (about one quarter mile distant)	N. 10° E.
Silver Peak (in Nevada) about	N. 15° E.
Piper's ranch (distant some five miles) about	N. 35° E.

On the east side of Piper's Valley, in a direction of north 50 degrees east to north 60 degrees east from here, there are two or three low hills which look like, and which probably are, isolated outbursts of basalt.

The claim of Greenly & Broder is called the Cliff Mine. It consists of several small veins of quartz, from one to four or five inches thick, which sometimes run with considerable regularity for some distance in various directions through the granite. These little veins contain, here and there, small quantities of enormously rich silver ores, small specimens of which, containing high percentages of argentite and stephanite (both of which minerals occur here), have assayed as high as $10,000 to $12,000 per ton. But there is very little gold here.

The old Cinderella Mine, now called the Boomerang, is in the lower part of the mountains, on the northwest side of Deep Spring Valley, between Deer Creek and Wymans Creek. It is a quartz vein, which, so far as visible, ranges from four to five feet thick; strikes about north 25 degrees east, magnetic, through the granite, and dips 55 degrees or 60 degrees to the northwest. An old shaft upon it, in which a man was once killed by Indians, is fifty or sixty feet deep. The first work upon it is said to have been done in 1863. One ton of the ore, worked in an arrastra on Wymans Creek, is said to have yielded $45, and one ton, shipped to Aurora, and worked in a mill there, to have yielded $125, chiefly silver.

A short tunnel, which has not yet reached the vein, and some shallow surface prospecting holes, are all the other work that has yet been done here, and the mine is idle now.

The trail by which we crossed the Inyo Mountains into Deep Spring Valley in 1870 lies several miles southeast of the present wagon road, and is now known as the Old South Trail.

Deep Spring Valley itself is surrounded on all sides by high mountains, and has no outlet for any waters which run into it. These waters, therefore, at times in the winter form a shallow lake of considerable area in the lowest or southern corner of the valley; but in the summer most of this water evaporates, leaving a broad mud flat covered with a white crust of tolerably pure common salt. The water, however, never entirely disappears from here, since along the foot of the mountains immediately south and southeast of the lake are numerous never failing springs, some of which are very copious. These springs are all cold. Some of the smaller ones are quite strongly impregnated with sulphur; but the larger ones generally contain little or no sulphur, and are good drinking water. Among them are two or three ponds one hundred feet or more in diameter, which are very deep, and in the bottom of which some very copious springs arise, which have given their name to the whole valley. A number of years ago some carp were placed in these ponds, where they seem to thrive and grow to a large size. But they are said not to be very nice eating, having a sort of muddy taste about them.

From Big Pine to Bishop Creek the odometer distance is a trifle over sixteen miles. Bishop Creek is the largest and most flourishing agricultural town in Owens Valley, having a good many square miles of nearly level and fertile land plentifully watered by large streams from the Sierra Nevada.

All the settlements of any importance in Owens Valley, excepting Keeler, are on the western side of the river, where much of the valley is well watered by never failing streams from the snow fields of the high Sierra.

But the railroad is built on the eastern side of the river all the way through a country which is practically an unbroken desert, as no streams of any considerable magnitude issue from either the Inyo or White Mountains. As a consequence, the various railroad stations in the valley are from two to five miles distant from the town to which they correspond, and being much nearer the river, are also generally on somewhat lower ground.

The following altitudes of the railroad stations above the sea, as determined by engineer's level, were obtained from the offices of the railroad company at Hawthorne, Nevada:

Benton	5,527 feet.
Bishop	4,145 feet.
Alvord (Big Pine Station)	3,960 feet.
Independence	3,796 feet.
Lone Pine	3,720 feet.

Bishop Station is about two hundred yards east of the site of the old, and long since deserted, town of Owensville.

It should be remembered that the Inyo and the White Mountains constitute in reality but a single continuous range, stretching northwest and southeast for a distance of a little over a hundred miles along the whole length of the eastern side of the valley, and with many culminating peaks, which rise to altitudes of from eleven thousand to thirteen thousand feet, or a little more, above the sea.

The northwestern part of the range is called the White Mountains, and the southeastern part, the Inyo Mountains. The somewhat arbitrary and indefinite line of demarcation, where the Inyo Mountains are generally considered to end and the White Mountains to begin, is about at the pass where the wagon road from Big Pine to Deep Spring Valley crosses the range.

The rest of what here follows relating to Inyo County is taken chiefly from my unpublished notes of 1870, when I spent considerably more time in this part of the country than was at my disposal here in the past summer.

Entering the county from the south by the road which comes from Walker Pass, it is about at Grape Vine Cañon, some five or six miles north of Indian Wells, that we cross the boundary line between Kern and Inyo Counties.

For about ten miles from Indian Wells, *i. e.*, as far as Sand Cañon, the road runs close along the foot of the Sierra Nevada. But on leaving Sand Cañon, it bears more northeasterly, away from the Sierra, and towards the long, black bluff, noticed as presenting such a remarkable appearance from our point of observation near Indian Wells. It approaches to within perhaps a quarter of a mile of the face of the bluff, and then follows northwesterly for several miles the narrow valley which runs along its foot. From Sand Cañon the road descends considerably towards the bluff, the surface being composed of granitic detritus from the Sierra. But the valley along the foot of the bluff has a gentle grade ascending towards Little Owens Lake. The crest of the bluff itself also rises somewhat towards the northwest, and about a mile south of Little Owens Lake it is crowned with a round-topped hill, whose color is a dark red instead of black. This bluff is in reality the edge of an extensive lava flow.

We found ourselves at Little Owens Lake entirely surrounded by scattered outcrops of this lava, most of which is very dark colored, fine grained, compact, tough, and heavy.

A large range of country to the east from here is thickly sprinkled with similar outcrops. The long bluff already described extends probably not less than twelve to fifteen miles southeasterly from Little Owens Lake. Its continuity is somewhat interrupted at the lake, but northwest of there it immediately begins again, and continues on for a mile or two further to the northwest. Little Owens Lake, whose water is fresh and drinkable, occupies a little cove at the foot of the lava bluff.

Very few of the volcanic hills which are scattered through the country east of here show anything like a crater form. One dark red cone, however, a few miles distant, is very conspicuous, bearing north 24 degrees west, magnetic, from Mr. Hoffmann's point of observation of May eleventh, near Little Owens Lake. Its conical shape, as seen from here, is perfect. It is close alongside the road we followed from Little Owens Lake to Owens Valley, and is a perfectly isolated hill rising several hundred feet above the valley in which it stands. Its sides are covered with apparently loose scoria, and on its northwest flank there is a ruined crater. A few miles beyond this hill the road passes through a sort of gateway formed by high red bluffs of porphyritic rock, and beyond here as far as Hayway, it winds about somewhat among the hills and ridges, which seem to consist of a considerable variety of volcanic materials. This portion of the road, however, we passed in the night.

From Little Owens Lake to Hayways, the distance is sixteen and three quarters miles, and from there to Olancha, at the southwest corner of Owens Lake, it is about eleven and a quarter miles.

In the region east of Little Owens Lake the volcanic rocks, as seen from a distance, appear to occur chiefly in the form of irregular and isolated patches, generally of no very great individual extent, though very numerous and scattered far and wide through the country, very often more or less bluffy, and generally very black in color, contrasting strongly with the elsewhere almost universal gray, and giving a peculiar aspect to the scenery.

These rocks do not seem generally to have flowed over any great continuous extent of surface, but appearances indicate rather that the greater portion of them have probably been lifted to the surface at or near the spots which they now occupy. But here and there may be seen a few unmistakable lava streams, which have flowed down some of the cañons, showing that this volcanic action took place after the face of the country had assumed essentially its present configuration. The color and general appearance of the lava forming these streams are precisely similar to those of the rock which forms the bluffs and patches elsewhere. One broad stream was noticed of considerable depth, which after flowing part way down a tolerably steep slope, had apparently stopped suddenly in its course and solidified there, its front forming a well marked wall of considerable height. There are also other appearances which seem to indicate that much of this material at the time of its ejection was neither liquid nor solid, but rather in a plastic state of semi-fusion.

A few miles south of Hayways a change seems to occur in the general character of the volcanic materials, the rocks becoming to a great extent porphyroid in texture, and lighter in color, while there are extensive beds of solidified ash and other debris, though our night travel gave very small chance for observation here.

To the eastward, also in the northern portion of the Coso Range, there are very few *black* outcrops to be seen. Yet these mountains have a suspicious look, and the country between them and the Sierra consisting so largely of igneous rocks, it is probable that volcanic materials still continue to occur to a greater or less extent throughout the Coso Range, nearly if not quite to the border of Owens Lake.

In places, as at Little Owens Lake, the volcanic rocks approach very near to the eastern foot of the Sierra. But I saw nothing in the Sierra itself which looked like volcanic rock between the farthest point which we could see to the south of Walkers Pass and the vicinity of Fish Springs, near the middle of Owens Valley, a distance of about a hundred miles in a straight line.

All along from Walkers Pass to Owens Lake we experienced pretty high northwesterly winds from the Sierra during the latter part of each day, and all the evening. This wind generally died away at about or shortly after midnight, after which it was calm till morning. In the early part of the forenoon a light breeze from the desert generally blew for awhile, coming from the southeast or south. Before noon, however, this breeze died away, and shortly after noon the northwest wind began to blow again.

At Olancha and elsewhere we heard strange stories respecting certain commotions which are said to have taken place, from time to time, in the waters of Owens Lake, without apparent cause. For example: Dr. G. Wiss, who lives at Olancha, told us that once during the week preceding our visit (*i. e.*, the first week in May, 1870), in the night, when there was not a breath of wind, he suddenly began to hear the sound of distant surf upon the lake. At first it sounded faint and far away, as if upon the opposite or northeastern shore. But the sound gradually increased, and drew nearer; the surface of the lake itself, which was previously calm, becom-

ing at the same time more and more disturbed, till finally the waves were beating and breaking upon the beach in front of the house with a heavy and constant roar, the commotion being as great as is ever produced in the lake by the heaviest storm. And yet no wind. After continuing this for awhile, it then began to die away, and the lake grew calm again, as gradually as it had become disturbed. All this with no apparent cause whatever. There was no wind, either before or after it; no tremor of the earth; nothing seen and nothing heard except the surf. He also says that the Mexicans about here, and all others who have been long acquainted with the lake, agree in stating that within a few years the water of the lake has risen considerably, and now stands eight or ten feet higher than it used to; while no apparent cause can be assigned for it, as no connection has been traced between the level of the water in the lake and the quantity of water flowing into it in different seasons, or in different years. He says further that a Mexican of his acquaintance named Severiano Arana, and upon whose word he relies, tells him that he once saw a fearful waterspout in the lake, near its center, about upon an air line from Olancha, towards Cerro Gordo. An enormous jet of water was suddenly thrown hundreds of feet into the air, carrying heavy bowlders of rock with it, the explosion being accompanied with reports resembling heavy thunder.

On hearing these stories, Mr. Hoffmann remarked that when he and Professor W. H. Brewer were upon Mono Lake in 1863, they both saw and noticed a disturbance of its waters, which the amount of wind that was blowing at the time did not seem adequate to account for.

With reference to Owens Lake, it is certain that the water, at the time of our visit, was higher by at least several feet than it had been at some time previously; for, at one or two points along the margin of the lake, I saw in the shallow water, near the shore, the dead sagebrush still standing where it grew, but entirely covered now with water. How reliable the balance of the stories may be I have no means of knowing, but am inclined to receive much of them *cum grano salis*. The lake has certainly risen, but its oscillations of level are in all probability due to the variations in the quantity of rain and snow in the Sierra. Seven miles north of Olancha, Cottonwood Creek flows from the Sierra towards the lake. This creek, when we crossed it (May fourteenth) was about eight or ten feet wide, perhaps a foot deep, and quite rapid. At the time of our visit to Cerro Gordo certain parties were talking of putting up smelting works on Cottonwood Creek, for the reduction of Cerro Gordo ores. This is not likely to pay, as it would require altogether too much transportation of the ore.

A mile or two north of Cottonwood Creek were noticed along the roadside many curious saucer-shaped deposits, formed by mineral springs now extinct. They occur thickly sprinkled through a bed of gravel, which is filled with bowlders of granite and metamorphic rocks from the Sierra. The saucers vary in diameter from a foot to four or five feet. Many of them are circular and perfect in form. But many of them have a bowlder of granite or other rock in the center, around which the spring which formed them happened to come up. In other cases, where the bowlder was too large for the spring to surround it on all sides, an incrustation or deposit has been formed on one side of the bowlder only. The general surface of the gravel has not been disturbed, therefore, since these springs were in action, and the springs themselves became extinct before they had time to pile up chimneys. The deposit is not white, but bluish gray, and resembles somewhat in appearance that formed at the Steamboat Springs, at Washoe, in Nevada.

From Cottonwood Creek to the village of Lone Pine is fourteen and one half miles. This was our starting point for work at Cerro Gordo, and the southern part of the Inyo Mountains.

The greater portion of Owens Valley ranges between eight and ten miles in width, and at no point probably does the width exceed twelve miles, measuring from foot to foot of the mountains proper, on either side of the valley.

Owens River, although its general course from Bishop Creek to its mouth is very straight, is nevertheless in its detailed windings one of the most crooked streams in the State, and the actual distance which it runs after entering the valley is probably between two and three times the total length of the valley itself, from its head to the lake. A strip of bottom land, varying from one to two or three miles in width, borders the river throughout the valley. The soil of this bottom land is generally good, and it is covered with grass, affording feed for considerable herds of cattle and horses, which are driven over here at times from the San Joaquin Valley. The feed is generally, however, rather coarse.

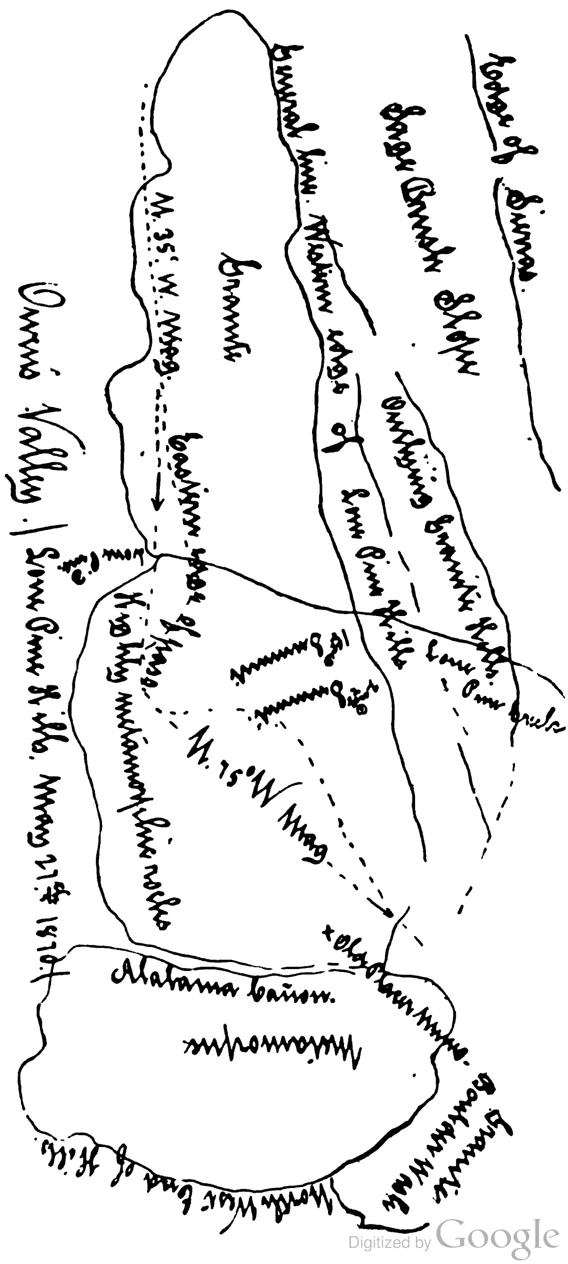
Skirting the edge of this bottom land, and between it and the foot of the mountains proper (though rising high enough against their sides in places to form respectable mountains themselves), on either side of the valley are the "sagebrush slopes," consisting of the "wash" from the mountains. On the western side of the valley this "wash" from the Sierra forms for many miles a continuous belt skirting the foot of the mountains, and varying from less than a mile to more than four miles in width. It here consists chiefly of granite débris in the form of sand, mingled with rounded pebbles and bowlders of all sizes up to several tons in weight. The distribution of the bowlders is, however, irregular. In places they are very thick over considerable areas, while other places are nearly free from them. These slopes are everywhere covered with sagebrush. Their general surface, as seen from a little distance, is very smooth, and they slope towards the central portion of the valley with a pretty uniform grade, of from 4 to 5 degrees. On the eastern side of the valley, the "wash" from the Inyo Mountains, though large in quantity, is by no means so great as that from the Sierra. It does not here form a continuous belt for any great distance, but each large cañon has its own distinct "wash," which has spread out in low conical form in all directions from its mouth.

The washes from separate adjacent cañons have often met and united, to a greater or less extent, at the edges; but in such cases there is always a trough between them which is lower than their central portions, and the irregularly rolling surface thus formed is neither uniform nor continuous. The slope of the lines of maximum descent, however, on all these washes is everywhere nearly the same, *i. e.*, from 4 degrees to 5 degrees. The bowlders and pebbles of this wash from the Inyo Mountains consist, not only of granite, but also of every variety of metamorphic rock which helps to form the range, which variety is, in places, large.

These heavy washes from the mountains form a prominent feature, not only of the country immediately along the eastern foot of the Sierra, from Walkers Pass to the northern extremity of the White Mountains at least, but also of all the country to the east, so far as our observation extended; though probably there are few, if any, regions where they are more strikingly developed than in Owens Valley and along the foot of the White Mountains. The volume of material which they contain is immense, and their height is very deceptive. When looking at them, either from the valley or from the mountain crests, one can hardly credit the statement that they rise from one thousand to one thousand five hundred feet above

the valley. Yet this is true, and probably, in places, their height considerably exceeds even the latter figure. The beautiful streams which flow over the wash from the Sierra to Owens River have been noted in Volume I of the "Geology of California," page 457. But on the eastern side of the valley no stream issues, in summer, from the Inyo Mountains anywhere between Owens Lake and the head of Owens Valley proper—at the southern edge of the volcanic table land which stretches across to the north of Bishop Creek.

There is an error in the statement of the length of Owens Valley, on page 455 of the report ("Geology of California," Vol. I), as the map will show. If we take the distance from McBrides to the mountains, which close around the valley south of Owens Lake, it is still considerably less than one hundred and forty miles. But the narrow and barren arm which stretches along the foot of the White Mountains from near Owensville to McBrides, hardly deserves to be called a part of Owens Valley; and if we limit the valley to the southern edge of the volcanic table land mentioned above, which is proper, its rectilinear length, and it is in reality nearly straight, will then be only about eighty miles. Immediately west of the village of Lone Pine there rises a mass of detached hills, forming a sort of outlier of the Sierra, and known as the Lone Pine Hills. The form of the general outline of these hills is nearly triangular, the apex of the triangle stretching southeasterly nearly to Owens Lake, while the broader end of the hills, forming the base of the triangle, extends to the northwest some four or five miles



beyond the village of Lone Pine. I estimated the highest points of these hills to be in the vicinity of one thousand two hundred feet above the valley. Their southeastern end and their southwest side, as far to the northwest as Alabama Cañon, consists of granite, while their northeast side is metamorphic, as shown in the sketch.

Behind these hills lies a portion of the "sagebrush slope," and several small streams break through them into the valley.

In their eastern margin, at a point about a mile from Lone Pine, some digging has exposed at one point a body of crystalline limestone. Near the same spot is a large mass, several hundred feet in thickness, of almost bluish hornstone, containing pyrites in small crystalline grains, disseminating through it in large quantity.

All the rocks in the eastern portion of the hills, though undoubtedly metamorphic, are very highly altered, and the stratification is nearly obliterated. Indeed, it is only from some little distance that any distinct sign of it can be seen. But viewed thus, it appears that the general course of the strike was nearly parallel with the eastern edge of the granite, and the dip southwesterly, or towards the granite at a pretty high angle. Possibly these strata may have been overturned. The granitic rock forming the western portion of the hills varies considerably in texture, etc. Some of it is pretty hard, but generally it is rather soft and weathers rapidly, disintegrating to a coarse sand. As a general rule also, it is very feldspathic, and contains much quartz, while the quantity, either of mica or hornblende, is small, though both are present. It contains a system of streaks or veins running through it, which vary somewhat both in color and texture from the rest of the rock, being generally more deeply stained with oxide of iron, and often exhibiting an imperfectly bedded structure. These streaks, which are quite numerous, show a tendency to a general approximate parallelism with each other, and with the main axis of the topography.

In the granite also, and irregularly distributed through a belt of no great width along its eastern edge, are patches of a fine grained, very hard and tough, dark-bluish rock, much of which has an igneous look. In some places this rock weathers a little, as if it were stratified or laminated, but generally it seems perfectly compact and solid. Much of it, when in thin pieces, rings like steel under the hammer, and it is entirely surrounded by the granite. This same rock, however, in places, contains in its turn streaks and nodules of epidote rook, whose fresh fracture is of a light grayish green, but which weathers to a bright apple green. A portion of Alabama Cañon, and one or two of its branches in the vicinity of the point marked "M" in the sketch, were at one time worked to some extent for placer gold. Most of this mining was in the gulch marked "M" itself, and in one or two of its smaller branches, the narrow bed of one of which has been worked to a considerable distance above where any water was ever brought to wash the dirt.

These "diggings" were abandoned long ago as exhausted, though they are said to have paid well for a little while, and gave rise to the formation of the Alabama Mining District. The rock which underlies them and forms the hills immediately to the northeast of them, though probably metamorphic, shows little signs of stratification. It appears to be chiefly feldspathic, and is neither decidedly granitic nor porphyritic in its texture, but something between the two. I saw no other rock in this vicinity except the granite to the west and southwest, nor did I see any signs of quartz veins here, though at one point a large opening has been made by miners and from seventy-five to one hundred tons of rock thrown out.

Although I have described the Lone Pine Hills first, my trip through them was not made until after one trip to Cerro Gordo and the southeast end of the Inyo Mountains. I now turn to the latter range. Before speaking of their structure, however, I will note the fact that no one seems to know, and that it is very difficult to tell, where the Inyo Mountains end and the White Mountains begin. There is no marked division between them, and they form in reality but one range, the lowest point of whose crest is probably very little, if any, under seven thousand feet above the sea. Near the middle, however, the range widens out and includes between some of its branches Deep Spring Valley, which lies to the east of the main crest. And for convenience of reference, rather than for any better reason, I propose in what follows to assume the trail which leads from a point in Owens Valley nearly opposite Big Pine Creek, across the range to Deep Spring Valley, as the line of division between the Inyo and the White Mountains. The Inyo Mountains, then (*i. e.*, that portion of the range which lies between the Deep Spring Valley trail on the north, and Cerro Gordo on the south), may also be divided into two portions—a southern and northern portion of nearly equal length—by the Pah Ute Monument, which stands on the crest of the range opposite the mouth of Mazourka Cañon.

The more southern portion will then consist of a single unbroken and narrow ridge, whose axis or crest forms the arc of a pretty uniform curve concave toward the east. The northern portion is not so simple in its topography. But the curve which is formed by the southern portion may still be followed uninterruptedly to a point opposite the head of Mazourka Cañon. At this point it would leave the crest of the divide, but it may be continued on directly through Waucoba Mountain, the highest peak in this part of the range, striking again the watershed of the range at a point a few miles beyond, and following it then to a point south of Deep Spring Valley. At this point the main crest makes a sharp bend back towards the west and northwest, passing west of Deep Spring Valley into the White Mountains. But the curve which we have already followed so far may still be traced on through the crest of the ridge southeast of Deep Spring Valley to the center of the little knot of mountains lying east of the northern portion of this valley. And thus, we finally note a nearly continuous ridge, which curves with remarkable uniformity through an arc amounting to nearly the quadrant of a circle, concave towards the east, and whose chord from Cerro Gordo to the mountains east of Deep Spring Valley is nearly sixty miles in length.

The widest portion of the whole range is in the vicinity of Deep Spring Valley. Northwest of here the White Mountains grow rapidly narrower, until they terminate in Mount McBride, the most northwesterly high peak of the range, on the Nevada State line. The western foot of the White and Inyo Mountains forms a continuous, unbroken line, which is nearly straight, from McBrides to the mouth of Mazourka Cañon, beyond which it follows the curve of the southern portion of the Inyo Mountains southeasterly toward Cerro Gordo. From its mouth in Owens Valley, opposite the site of the deserted village of Bend City, Mazourka Cañon runs nearly north some twelve or fifteen miles into the heart of the range, leaving to the west a broad spur between it and Owens Valley. Around the head of Mazourka Cañon, and to the north of it, the mountains close into a broad, irregular mass, of which Waucoba Mountain, a smooth and round topped crest, is the culminating point. The watershed of the range, however, does not pass through this mountain, but makes a short bend around the head of Mazourka Cañon to the northwest, which direction it

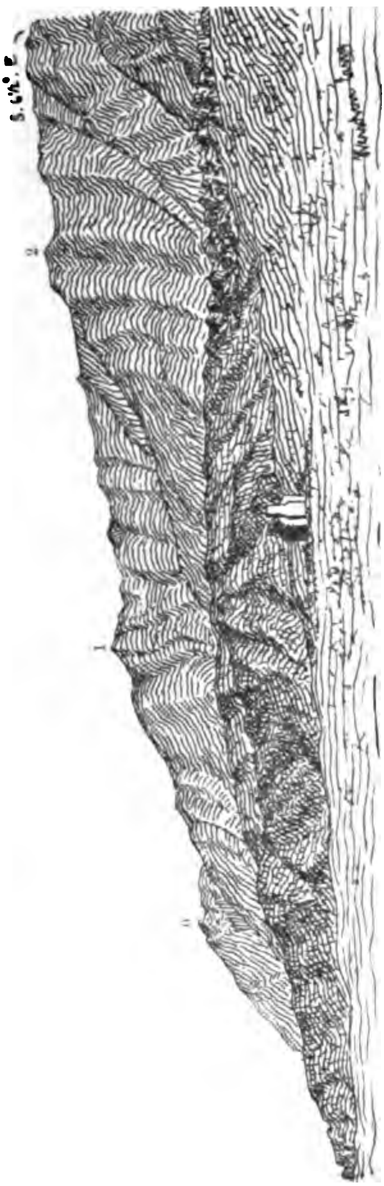
follows for some five or six miles, and then bends sharply back again to the northeast, and returns to the eastern edge of the range, where it bends to the north, and follows again the course of the general curve already described. It will be seen, on reference to the map, that the watershed of the northern part of the Inyo Mountains, south and southwest of Deep Spring Valley, incloses a broad amphitheater, whose general surface has rather a gentle slope towards its central portions and towards Owens Valley, into which it drains, but which has been cut up in detail by streams into a perfect mass of little sharp ridges and steep cañons, to which I shall have occasion to refer again hereafter.

The Sierra Nevada, to the west of Owens Valley, when seen from the crest of the Inyo Mountains, presents even a grander appearance than it does when seen from the valley. The view from here extends further back among the snow-capped peaks of the great crest of the chain, large portions of which are hidden from the valley by the lower, but nearer, peaks in front. Mount Whitney, and several others among the highest peaks of the range, are in full view. But it is not the individual peaks which strike so deeply the attention of the beholder.

The difference of level between Owens Valley and the crest of the Inyo Mountains is, in general, not much more than half as great as it is between the valley and the Sierra. From the Inyo Mountains tops, therefore, the culminating peaks of the Sierra Nevada are still seen towering higher above us, crowning the great wall of granite which bounds the valley to the west. But the difference of the height between these culminating peaks—the difference even between the summit of Mount Whitney itself—and the general height of the crest of the range in this vicinity, is not sufficiently great to permit any one of these to stand out separately and prominently among the most striking features of the scene. It is the *Sierra Nevada and its great ragged crest*, and not the individual peaks, which are especially grand as seen from here. To the north and south, the great ridge stretches on, the view extending from the vicinity of Walkers Pass, on the south, to that of Bishop Creek, on the north (an air line distance of fully one hundred and twenty miles), and I have never elsewhere seen so grand a mountain front as this.

There is one peculiarity which I noticed in the shape of many of the most prominent peaks of the Sierra, from Owens Lake north, as far as Bishop Creek. The shape alluded to, as seen from the east, appears to be that of a short ridge, whose axis is nearly parallel with that of the range, and whose highest point is at the northwest end, and whose northwest face is a precipitous, and frequently nearly a vertical bluff. In the opposite direction, from the highest point, the crest runs off some little distance with a gentle slope, and then descends more rapidly towards the southeast (though not so steep as the northwest face), to the general level of the mountains around.

This is the general form of Mount Whitney itself as seen from the eastern edge of Owens Lake, and it is the only single form which I noticed as being frequently repeated in the high granite peaks further north. It is very common, and I am at a loss to know its cause. Is the granite itself in reality bedded, and are these ridges results of a nearly obliterated stratification, the direction of their axis indicating its original strike? Or, if the granite be igneous in its origin and massive in its eruption, then, what has produced these forms? And why is it that wherever this form does occur, the highest point and steepest bluff, without exception, so far as observed, are uniformly at the northwest end? There must have been some cause for it. This form, with slight variations, is reproduced too frequently to be the



(0=S. 20¼° E.; 1=S. 16¼° E.; 2=S. 10° E.)

1 A.

These cuts, 1 A to 9 A, inclusive, represent a continuous view of the Sierra Nevada, as seen from a point near the site of Bend City, extending from a point near Walkers Pass on the south to Fish Spring Volcano on the north—a distance of about seventy miles.

result of accident only, and some general cause tending to produce it must have acted over a very large region on this portion of the Sierra. The general structure of the Inyo Mountains may be stated in few words, by saying that they consist of isolated patches of granitic rock of greater or less extent, distributed generally through their central portion, and flanked and surrounded on all sides by metamorphic sandstones, slates, and crystalline limestones. In traveling north from Cerro Gordo, New York Butte is the culminating point of the first mass of granite. The second one forms the

crest and central portion of the range for several miles on either side of the Pah Ute Monument. A third mass forms Waucoba Mountain and the region in its immediate vicinity, and a fourth one forms a considerable portion of the spur to the west of Mazourka Cañon and between it and Owens Valley. These four comprise all the large bodies of granite over which our travels in the range extended, though there are probable indications, as will be noted hereafter, of the existence of at least another considerable patch in the region which we did not visit between Mount Hahn and the Pah Ute Monument. The stratified rocks in this range are everywhere much contorted. But their general strike is nevertheless northwesterly, approximating, more or less, closely to parallelism with the axis of range, and their general dip on the southwestern side of the range, though there are large exceptions to this rule, is southwesterly, or toward the valley.

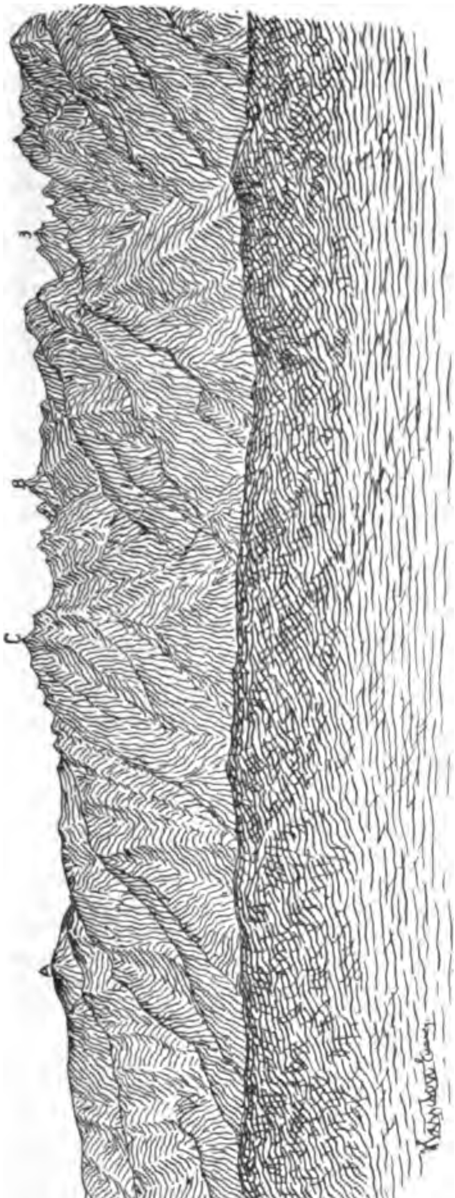
The eastern slope of the range I saw only from a distance, *i. e.*, looking down upon it from the summit, as we nowhere descended that side of the range, except in our trip to Deep Spring Valley. With reference to the stratification of the eastern slope, therefore, I can only give the appearances as seen from different points in the crest of the range, subject to whatever error may be due to deception in perspective and distance. This I will do in the sequel.

Cerro Gordo and Belmont are on the southeast extremity of the crest of the Inyo Mountains. Beyond Belmont the range descends immediately and abruptly towards the south, and loses itself in the region of comparatively low hills between here and the Coso Mountains.

The road from Lone Pine to Cerro Gordo follows the valley and the northeastern shore of the lake to a point two or three miles southeast of the Swansea Smelting Works, where it turns to climb the mountains. These smelting works were erected to work Cerro Gordo ores. I was informed, however, that up to the time of our visit they had not been pecuniarily very successful. They have one prominent disadvantage in competing with the works at Cerro Gordo, being compelled to haul all their ore some six or eight miles down the mountains.

The western foot of the Inyo Mountains here consists almost entirely of limestone, generally highly metamorphic and crystalline. Some of it seems to be very pure. But it varies greatly in this respect and presents a great variety of colors, from white to pinkish, red and brown, and bluish and nearly black. Some of it has the appearance of being quite heavy-bedded, while other portions are very thin-bedded indeed. This mass of strata, consisting chiefly of limestone, extends at this locality about one third of the way from the foot to the summit of the mountains. Above it comes a series of alternating and highly metamorphosed strata, comprising very thin-bedded clay, slates, and shales of many shades of color, such as blue, gray, black, and brilliant red (nearly the color of hematite powder), brown, greenish, etc. Shaly sandstones, sometimes very thin-bedded, calcareous clay rocks, a pretty well characterized porphyry, a rock with granitic texture and appearance, but containing little or no mica, all apparently stratified and alternating here and there with beds of limestone, though in places the stratification of the more highly crystalline rock has been considerably obscured. From base to summit of the range these strata have been locally bent, broken, and twisted to such an extent that, if one were to consider but a small area at a time, it would often be difficult, if not impossible, to make out any definite system with reference to their directions of strike and dip.

And, it may be remarked here once for all, that this last statement is one which applies not only to the rocks of this locality, but also, to a great



(A=S. 2¼° E.; B=S. 6¼° W.=Saw Teeth; C=S. 4° W.=Lone Pine Peak, which hides Sheep Mountain from here; E.=S. 15° W.)

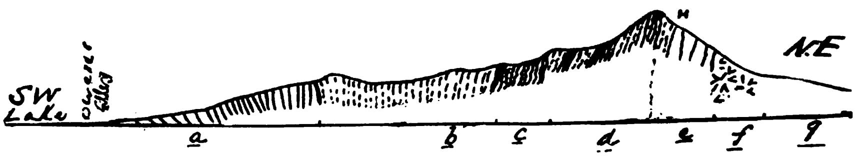
2 A.

extent, to all the stratified rocks of the Inyo Range, from one extremity to the other. In considering large areas, however, it is generally not difficult to trace the general law which governs the position of the strata. Statements, therefore, relative to the strike and dip of the beds over any considerable area in these mountains, must be always understood as referring only to their general course, and as being subject to all sorts of exceptions

if the rocks be taken in minute detail. The exposures are generally fine, sometimes magnificent, and the contortions of the variously colored strata are sometimes very beautiful.

At the locality now under consideration, the general strike is about north 50 degrees west, to north 60 degrees west, magnetic. The dip, which near the foot of the range is to the northeast at a gentle angle, increases rapidly in steepness as we ascend the mountains, and finally passes the vertical, the strata towards the summits of the range dipping generally to the southwest at a high angle.

The following sketch exhibits a general section of the strata from the foot of the mountains southeast of the Swansea works, to, and a little beyond, Spring Peak in the crest of the range, a little north of Cerro Gordo:



a—Crystalline limestones, much contorted, but the dip generally northeast, and increasing from about 25 degrees for a minimum near the foot of the mountains, to about 75 degrees for a maximum at the upper margin.

b—Alternations of thin limestone strata with shaly sandstones, and heavy beds of argillaceous and calcareous slates and shales, often extremely thin bedded, with occasional bands of still more highly metamorphosed, and sometimes even porphyritic rock. Angle of dip, very high, and gradually passing the vertical, thus changing from northeast to southwest in ascending the mountains.

c—Alternations of slates and shales with more highly metamorphosed rocks, in which the stratification is often, in spots, nearly obliterated.

d—Highly metamorphosed rocks, dipping at high angles, and generally to the southwest. Much rock that is granitoid in texture, but not granite, and contains little or no mica; and some well characterized porphyry, with sharp and distinct feldspar crystals, but all apparently stratified.

e—Heavy-bedded crystalline limestones, containing the Cerro Gordo mines a little further south.

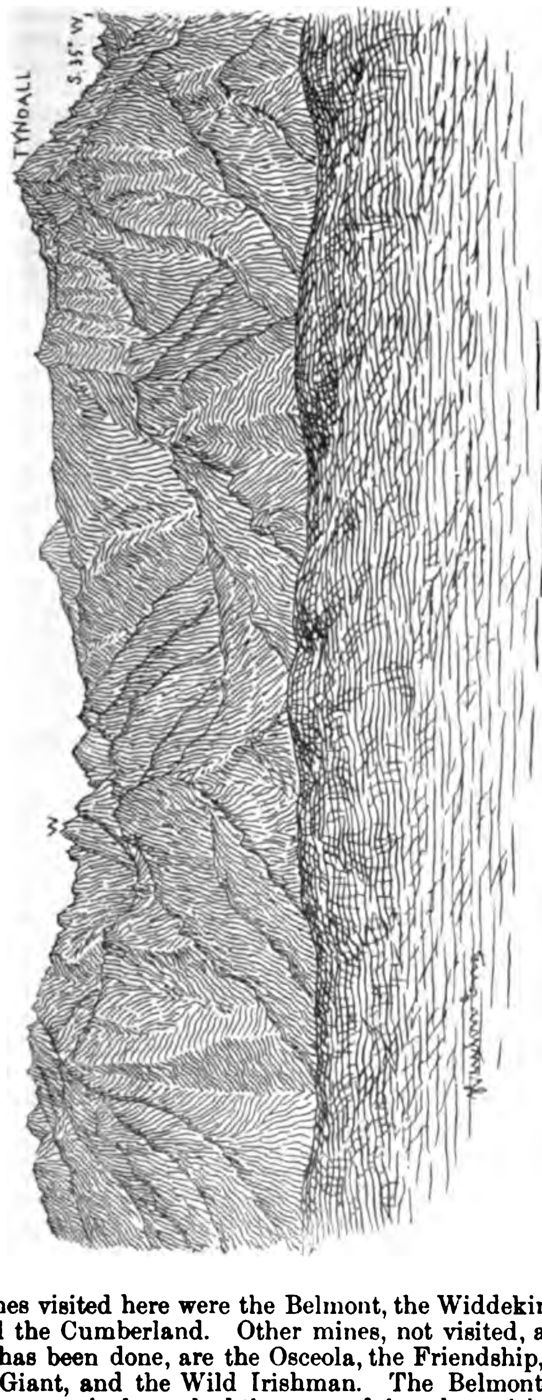
f—Crystalline rock of granitoid texture, similar to that containing the Belmont mines further south.

g—Unknown, but probably stratified rocks.

The limestone strata here, near the foot of the range, are occasionally intersected by igneous dikes, which generally strike more nearly east and west than the limestone, and stand nearly vertical. These dikes, however, were observed only at this locality, near the southeastern extremity of the range; and besides them, there appears to be nothing volcanic in the Inyo Mountains, except the few outbreaks on the western flank, near Fish Springs, in Owens Valley.

Cerro Gordo, and its vicinity, form the only locality in the Inyo Mountains where mining has hitherto been made a profitable business for any continued length of time, though I certainly know of no reason why it should not be made so in some other portions of the range, if properly managed. The mines of Cerro Gordo proper, are in massive or heavy-bedded limestone, and their ores consist essentially of argentiferous, antimonial, and arsenical galena. These ores form irregular deposits, and not veins, in the limestone.

Belmont is about three miles, by the trail, southeasterly from Cerro Gordo, and not far below the summit, on the southeastern front of the range. I will first give what notes I have of the mines at this locality. These mines are not in limestone. They are argentiferous quartz veins, traversing a crystalline rock of granitoid texture.



(W=Mount Whitney. This is the highest peak in the United States south of Alaska.)

3 A.

The mines visited here were the Belmont, the Widdekind, the Crowning Glory, and the Cumberland. Other mines, not visited, at which more or less work has been done, are the Osceola, the Friendship, the Sam Lucas, the Little Giant, and the Wild Irishman. The Belmont Mine has been much more extensively worked than any of the others visited. It had been

opened by a tunnel on the vein, between three hundred and four hundred feet in length, and by a drift from the shaft, at a higher level, extending beyond the tunnel, making the total distance opened on the vein about five hundred feet.

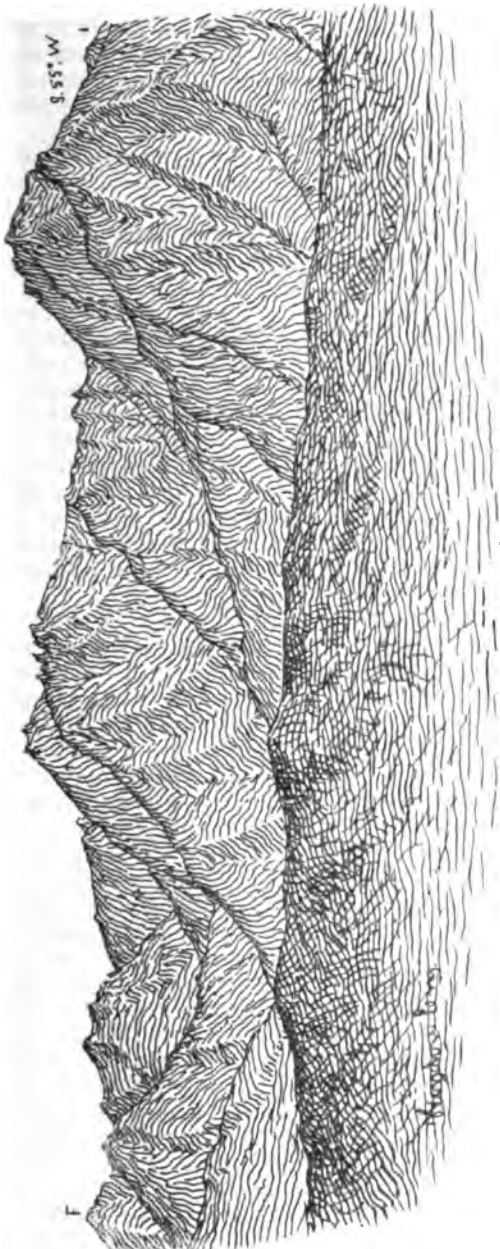
At the time of our visit a large quantity of rich ore was standing in reserve in the "backs" of this mine. The vein varies in thickness from six or eight inches to three or four feet. It also varies much in strike and dip, and the vein matter, as well as the wall-rocks, have been much shattered and crushed. But the vein was continuous as far as worked, and its general course was about north 75 degrees west, magnetic, and its dip 60 degrees to 70 degrees southwest. The Widdekind Mine is a short distance to the west of the Belmont, and is supposed to be upon the same vein. A shaft had been sunk here upon the vein, eighty feet, with an average inclination of about 60 degrees to the south. From the foot of this shaft drifts had been run eighty feet towards the southeast, and forty feet northwesterly. At higher levels two other short drifts had also been opened, about forty feet southeasterly from the shaft. The maximum thickness of the vein in this mine was at one place between six and seven feet.

The Crowning Glory Mine is about three fourths of a mile northwesterly from the preceding. A shaft was down here some sixty to seventy feet, and had furnished a little rich ore. No drifting had yet been done. The vein at the bottom of the shaft was about four feet thick. The Cumberland Mine is a few hundred feet northeasterly from the Belmont. No regular vein had been found there. A slope had been sunk about forty feet, with an inclination of about 40 degrees, and a small quantity of very rich ore extracted from the bottom. The gangue of all these mines is chiefly quartz; but they contain also calcite, especially in the forms of "dogtooth" and "nailhead" spar. Among their other minerals are galena and antimonial lead ores, malachite, azurite, pyrite, chalcopyrite, argentiferous gray copper ores, and small quantities of still richer silver ores. At the Widdekind Mine, native silver is also found, and the silver from here is also said to contain a little gold. The quantity of lead, however, in these mines is small, their ores being chiefly silver ores proper.

The Belmont Mine at the time of our visit was said to be yielding about three tons of first class ore per day. It was also stated that in the month of April, 1870, rather less than one hundred tons of ore were shipped from here to Cerro Gordo, but that the product for May would exceed one hundred tons. This ore was all packed on mules three miles to Cerro Gordo. All the water used at Belmont was also packed in kegs from Cerro Gordo, at a total cost of 12½ cents per gallon; water being worth 3 cents per gallon at Cerro Gordo. The cost per ton of the first class ore from the Belmont Mine was stated to be about as follows: Mining, \$2 50; sorting, \$5 50; transportation to Cerro Gordo, \$9; incidentals, dead work in mine, etc., \$5; total, \$22 per ton.

Their charges for working these ores at the Cerro Gordo Smelting Works were stated to be as follows: First, \$60 per ton of two thousand pounds of ore; second, 20 per cent of the balance of the yield of the ore after deducting from it the above \$60. For example, if two thousand pounds of ore yield \$200 in silver, the charges would be:

Sixty dollars per ton	\$60 00
Twenty per cent of (\$200 — \$60 = \$140)	28 00
Total cost of reduction	\$88 00
Add now to this the cost of mining, etc.	22 00
Total cost to the miner	\$110 00



4 A.
(F=Mount Brewer.)

It will be seen, therefore, that according to this statement, the net profit to the mine owner on ore from the Belmont Mine, yielding $200 per ton in silver, is just $90 per ton. It was stated, furthermore, that no account was given by the smelting works of any gold which the ores might con-

tain, and that the balance in silver, which was due the mine owners after the reduction of the ore, was purchased by the smelting works at $1 15 per ounce, troy. I am recently informed, however, that since our visit a change has been made, and that the smelting works now buy all their ores. The first class ore from the Belmont Mine was said to average about one hundred and sixty-five troy ounces of silver per ton.

On the return to Cerro Gordo Mr. Hoffmann took some bearings from the summit of Buena Vista Peak. This mountain, so far as seen, consists entirely of bluish crystalline limestone. From here I noted that in the northern extremity of the Coso Mountains, southeast of Owens Lake, the strata seem to dip southwest, and volcanic beds are spread unconformably over their upturned edges.

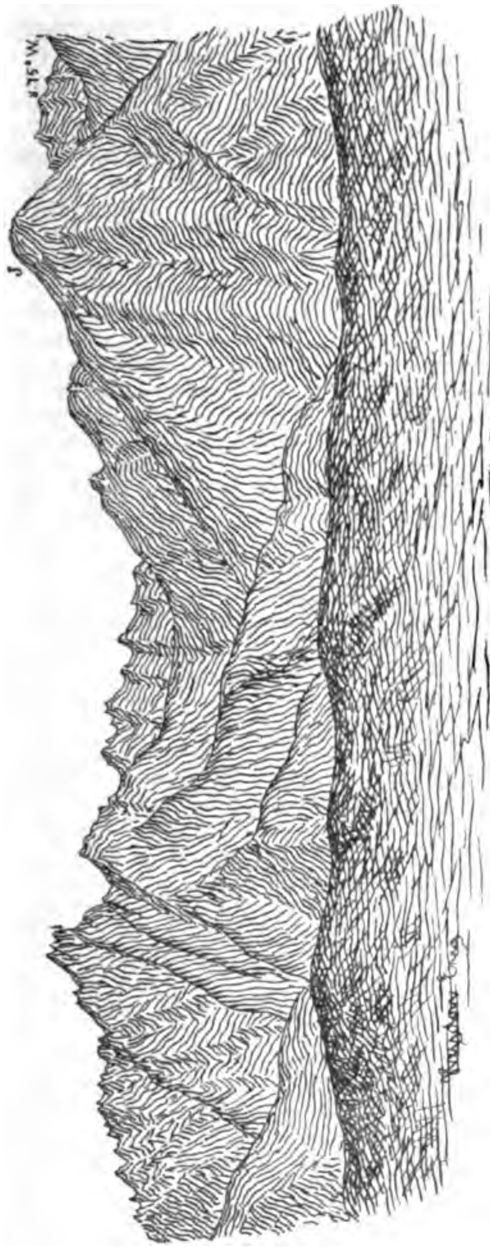
The San Felipe has been one of the most prominent mines of Cerro Gordo proper. It is entirely in limestone. A tunnel runs easterly several hundred feet into the mountains, and drifts run north and south sixty to eighty feet from it. There is no vein, and the mine consists entirely of a series of very irregular chambers in the limestone, which is massive, and has been much shattered and broken. It is filled with cracks in every direction, and sometimes large cavities occur. Some of the chambers have been quite large, and furnished several hundred tons of good ore. The ores here are chiefly galena, and arsenical and antimonial lead ores, containing considerable silver. Copper in any shape is scarce, though it is occasionally seen. A little pyrite is present. Some oxidized ores of lead are also present, *i. e.*, carbonates, sulphates, etc.

The other mines at this locality are said to be similar to this one in general character. I visited but one, the Miami, where a shaft had been sunk fifty feet deep, and about one hundred tons of ore taken from it.

The smelting works at Cerro Gordo consist of two reverberatory furnaces (called galimadors), and two shaft furnaces, with a small steam engine to drive a blower for the latter.

The ore from the Belmont and adjacent mines, called "silver ore," is mixed with the ore purchased from the Cerro Gordo mines proper, called "galena," or "lead ore," and with the finely pulverulent and yellowish ore containing oxidized ores of lead from the same mine, called "sand," and this mixture is fed to the galimadors, which are heated entirely with wood. In the galimadors the ore is partially roasted and slowly fused down to a black and heavy slag, the production of metallic lead being avoided here as much as possible. The floor or hearth of each galimador slopes back uniformly from the fire bridge to a sort of trough at the rear, where the melted slag accumulates. The galimador is kept constantly running. Every three or four hours a fresh quantity of ore is added and every twelve hours the accumulation of fused slag is drawn off, and allowed to spread over the floor of the building in a large, flat cake, from two to six inches in thickness, which, when cold, is easily broken up with hammers. It next goes to the shaft furnace. These furnaces, of which there are two, are cylindrical, and are twenty-two inches interior diameter and fourteen feet high from tap hole to bottom of charge hole at the top.

The interior of these furnaces, as well as that of the galimadors, is lined with a material consisting of crushed barren quartz, mixed with a clayey material obtained in the vicinity, and which is simply a decomposed feldspathic rock of a granitoid texture, similar in original character to that which forms the country around the Belmont and adjacent mines. The furnaces are run entirely with charcoal, the ore, flux, and fuel being charged in alternate layers. The ordinary load for each layer of charcoal is said to be five shovelfuls of broken slag from the galimadors, three shovelfuls



5 A.

(J = Kearsarge Peak.)

of silver ore, and one shovelful each of galena, sand, and limestone. The reduced argentiferous lead is drawn off from time to time at the bottom, and run into bars weighing about ninety pounds each, and called "bullion," while the slag runs away.

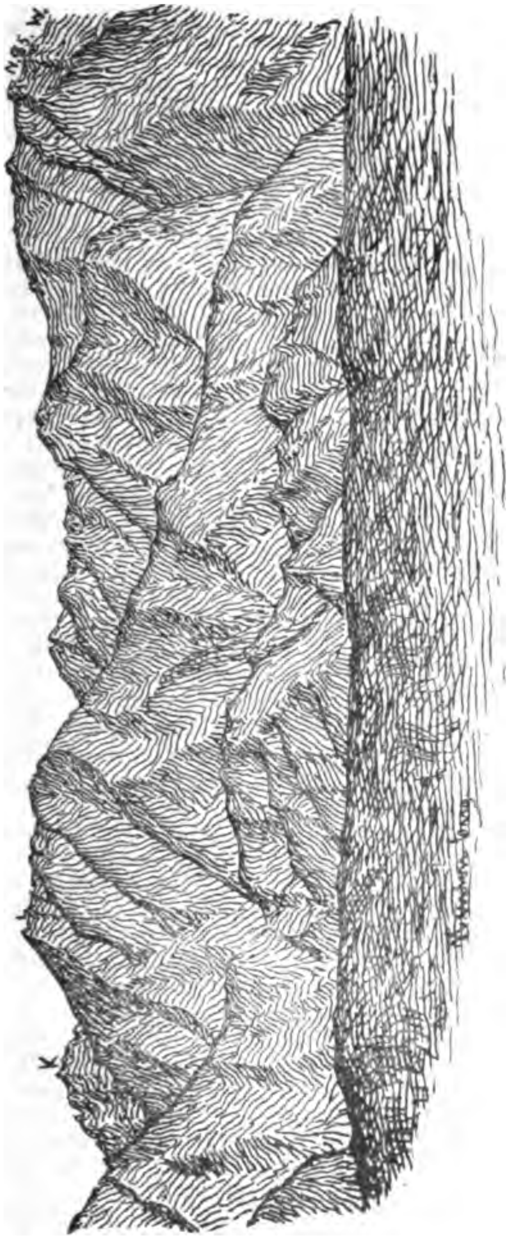
Mr. Hart, the Superintendent of these works at the time of our visit, informed me that when running with one galimador only, they use about one and three fourths cords of wood, thirty bushels of charcoal, and from ten to twelve tons of ore per twenty-four hours, producing from ninety to one hundred bars of bullion, worth from $19 to $20 apiece. The charcoal costs them from 33 to 35 cents per bushel, and the wood about $7 per cord. He also stated that the slag, which they were then throwing away from the shaft furnaces, contained about 35 per cent of lead, which there was no object in attempting to save, since if it were saved it would not more than pay its own freight to San Francisco. It is evident that these smelting works constitute at present decidedly the most valuable *mine* in the Cerro Gordo Mining District.

We left Cerro Gordo May twenty-first, and traveled northerly along the crest of the range. At a point about one and one half miles from the town, on the very crest of the range, a little south of Spring Peak, we found in the limestone some crinoids, of which we gathered specimens. Continuing on, we camped on the crest of the mountains, near the little spring from which the water is carried in pipes to Cerro Gordo, and about five miles from town. The next night we camped on the northwest slope of New York Butte, a few hundred feet only below its summit, and spent some three hours in gathering from among the rocks and bushes the scanty remnant of the last snow squalls, and melting in a small coffee pot and frying pan sufficient snow to water our four animals and ourselves.

In traveling along the crest to-day the rocks for, perhaps, two thirds of the way were slates, with bands of limestone intercalated, and here and there small patches of crystalline rock, with granitoid texture, whose origin is certainly doubtful, and which often suggests the possibility that it may constitute intrusive dikes, though I am more inclined to think it metamorphic. The dip of the stratified rocks here is generally very high, and often near the vertical, but generally southwesterly. In the flanks of the mountains below us the strata are very much bent and twisted. But the general dip is southwesterly, on both sides of the range, so far as we could see and judge, excepting that in one locality, on the eastern slope, a pretty distinct anticlinal axis could be traced for a mile or more in a northwest and southeast direction, beyond which it was again lost. This anticlinal appeared to run obliquely to the axis of the range, bearing more to the west of north than the latter. As we approach the New York Butte, the rocks over which we traveled grew more crystalline.

At one point, about a mile a little east of south from the summit of New York Butte, a small outcrop was seen of a dark, iron-red rock, consisting very largely of garnet crystals, of all sizes up to one half an inch in diameter. I obtained a good specimen of these crystals, many of which are modified with planes on the dodecahedral edges. Other rocks in this vicinity contain much epidote. Very soon after passing this garnetiferous outcrop, granite makes its appearance, and the summit and the main mass of New York Butte consists of granitic rock, which, however, varies largely in its character, particularly in the proportions of mica and hornblende, which it contains, varying from granite to syenite. It appears to be everywhere hard, and generally very feldspathic. It is also spotted here and there with prophyry and kindred rocks.

A red bluff, about a mile southeast of New York Butte, of which it is a spur, consists of limestone, slate, etc., which, on its south side, strikes nearly true north and south, and dips about 55 degrees west. But the strata are bent, and on the north side of the hill the strike is more northwesterly. This hill seems to contain many veins of some kind running



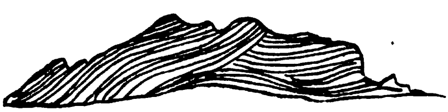
6 A.

northwesterly, which are conspicuous, from a distance, in the face of the bluff.

From New York Butte we continued on nearly to the summit of Mount Hahn, which, however, we did not reach, as the crest here became too ragged to allow of the animals going further, and we were obliged to descend. This we did, following the cañon which runs southwesterly from

the crest just south of Mount Hahn. When about two thirds of the distance down the mountains night overtook us, and having found water, we made camp in the bed of this cañon.

The next morning (May twenty-fourth), the cañon below being too precipitous to follow further, we came out of it and followed the spur on its north side, coming out at the mouth of the next large cañon north of this spur, whence we returned to Lone Pine. In the long, low spur which runs down through the center of the large cañon going down northeasterly from the crest just southeast of New York Butte to Salinas Valley, and which divides this cañon into two parts, from top to bottom, the strata for a considerable distance seem to strike northeasterly, *i. e.*, nearly parallel with the axis of the spur, and dip southeasterly. The following sketch exhibits the appearance, as seen from the southwest, of the strata on the summit of a high hill a little east of the crest of the range, and bearing about north 28 degrees east, magnetic, a mile or so from New York Butte.

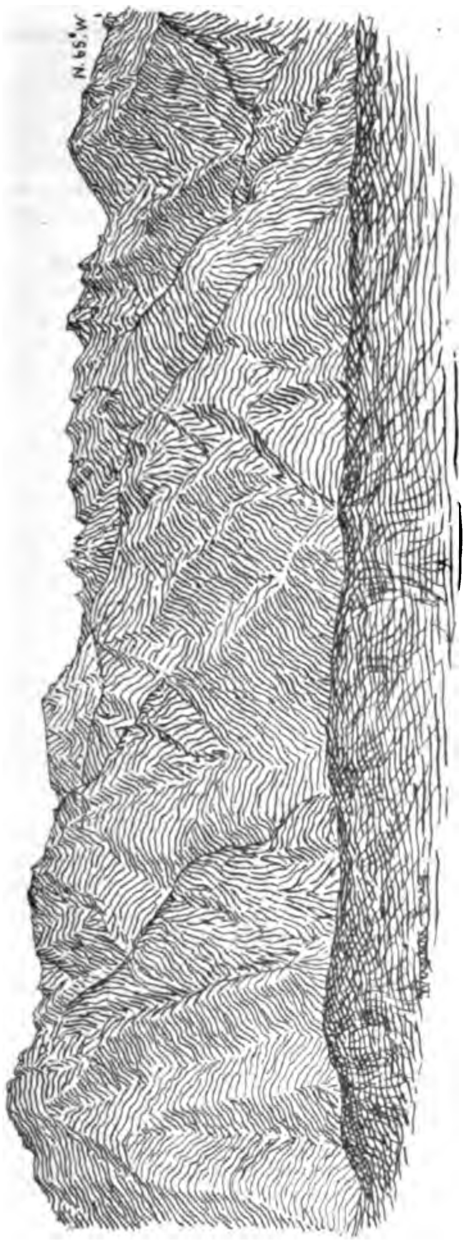


This hill is the culminating point of a heavy spur, which runs down about north 15 degrees east, magnetic, to Salinas Valley. For a mile, perhaps, on its course northeasterly from the crest of the range, this hill is beautifully stratified in very thin variegated layers, whose general position seems, from a little distance to the west or southwest, to be horizontal, and probably in this side of the hill is nearly so. The small local folds and twists in these beds are, however, innumerable, and often very sharp. Towards the southeast these beds abut squarely against the granite, which here forms the crest of the range. In the lower portion of this spur the stratification could not be well seen. About a quarter of a mile beyond its head, on the crest, towards the northwest, we reached the northern edge of this body of granite, and here also the slate and limestone strata abut squarely and sharply against it, striking about north 55 degrees west, magnetic, and dipping 45 to 65 degrees to the southwest.

We were at first inclined to suspect that the rocks forming the crest of the spur, as sketched above, might rest unconformable upon the lower rocks; but this is probably not the case, for later, when we obtained a view of the northwest side of this same spur from top to bottom, we saw in it a very well marked anticlinal bend, the beds in the lower portion of the spur dipping northeasterly. This anticlinal (which may indeed be only local) appears to pass entirely to the eastward of the granite.

The strata, which on the crest of the mountains abut so squarely against the northwest edge of this body of granite, show no evidence of having been locally disturbed by the granite. Furthermore, the flexures and contortions of the strata, just described, in the spur northeast of the granite, are not of such a character that they can with any certainty be ascribed to the action of the granite itself. Nor, generally speaking, do the strata in the vicinity of the granite appear to be more disturbed than they are elsewhere in the range. They seem rather to follow their course independently of the position occupied by the granite, abutting against it without special disturbance where they happen to meet it, and resuming their general course again beyond.

A more detailed investigation here would of course develop many facts bearing upon this point which escaped my notice, and it must be remembered that local disturbances here, as well as everywhere else in the Inyo Mountains, are very varied, complex, and numerous. All that I wish to be understood as saying, is that in no instance was I able to trace any definite



7 A.

connection between them and the position of the granite. I am very doubtful with respect to the origin of this granitic rock. It occupies, indeed, the center of the range, and the line of contact between it and the surrounding rocks is sometimes very sharp, though it is by no means always so. But, as already stated, there is much variety in the texture and composition of the granitic rock itself, and so far as could be seen in all its other relations

to the stratification and position of the surrounding rocks, it has quite as much the appearance of an isolated patch of higher metamorphism as it has of an intrusive and eruptive mass.

Just south of Mount Hahn, a sharp and narrow saddle, some hundreds of feet lower than the general height here of the crest of the range, separates the heads of two large cañons, one of which we followed towards Owens Valley, while the other one runs northeasterly to Salinas Valley. In the latter cañon, about two miles from the summit and perhaps two thousand feet lower down, is a spring of water. Mount Hahn appeared to consist entirely of stratified rocks.

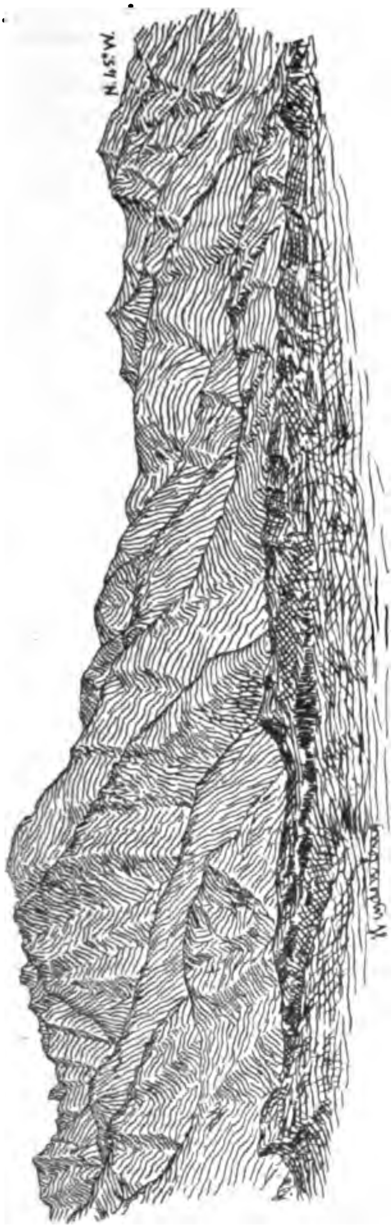
So far as could be seen, in following the cañon down the western slope of the mountains to Camp No. 24, the country consists of very highly metamorphosed rocks, in which the stratification is to a great extent, and sometimes entirely, obliterated. It is possible that some of these rocks may be intrusive, though probabilities seem to point in the other direction. Wherever the stratification could be seen, the general strike was northwesterly and the dip southwest.

This cañon has apparently at some time received the discharge of one of the "waterspouts," or "cloud bursts," for which this country is noted. At all events, a powerful and sudden stream of water has, for a mile or two on its course, washed out a channel, averaging eight or ten feet deep and from fifteen to twenty feet wide at the top, through the gravel which forms its narrow bed, and has piled up the loose gravel at the edges of this channel in little continuous ridges on each side, from one to two feet high above the surface beyond. All the rocks over which we traveled from Camp No. 24 to the foot of the mountains in the spur to the north of this cañon, though probably metamorphic, are very highly altered, the stratification being generally difficult to make out, and often entirely obliterated. The strike, however, was probably northwesterly, and the dip, wherever any traces of it could be seen, appeared to be southwest. The rocks vary somewhat in character; but the greater portion of them consist of a pretty well characterized porphyry, rather tough, but not very hard, and breaking very irregularly. The compact base of this rock is generally of a dark brownish-red color, and contains tolerably large crystals of white and greenish-white feldspar.

In all the rocks of this vicinity the green mineral, epidote, is very plentiful in incrustations and other forms, and certain portions of the porphyry above described contain small nodules, consisting of radiated acicular crystals of a brilliant green. In some specimens these little nodules are distributed through the rock almost as plentifully as the white feldspar crystals, and contrast most beautifully with them in the dark red base of the rock.

Near the foot of the mountains we saw considerable of a very fine grained, compact, hard, and tough, dark-colored rock, which frequently has more or less of a greenish tinge, though generally of a dark bluish shade, and much of which, in hand specimens, it would be difficult, if not impossible, to distinguish from certain varieties of igneous rock. It might, perhaps, be unsafe to assert that no portion of this rock is in reality eruptive. But I am strongly inclined to believe that it is not, and to consider it all as metamorphic, being probably a highly altered sandstone. I noticed no limestone near the foot of the mountains in this spur.

From the point at which we reached the foot of the mountains here, we had to travel about nine miles southerly through the easterly portion of the valley to reach the bridge which crosses Owens River, and in this region the whole surface, for miles, is thickly strewn with very small and much water-worn pebbles (from the size of grains of coarse sand up to half or



8 A.

9 A.

three quarters of an inch in diameter) of obsidian and other volcanic rocks, which are also intermingled with the sandy and gravelly soil.

The point at which the change appears to take place in the general dip of the rocks near the foot of the mountains, bears about north 50 degrees east, magnetic, from Lone Pine; the rocks southeast of this point and low in the mountains dipping northeast, while northwest of these they dip south-

west. But again, beginning at a point which bears about north 2 degrees or 3 degrees west, magnetic, from Lone Pine, and in the vicinity of the Eclipse Mine, there is another large body of rocks in the lower part of the mountains which dip northeasterly, as will be mentioned further on.

On the twenty-ninth of May we broke up our camp at Lone Pine and I made a trip (already described) through the Lone Pine Hills, then went to Independence, and late in the evening reached our new camp on the left bank of Owens River, close by the site of the deserted village of Bend City.

In connection with the description already given of the Lone Pine Hills, it should have been mentioned that beyond them for two or three miles northwesterly toward Independence, the whole breadth of the "sagebrush slope" is covered with gravel and granitic bowlders of all sizes up to many tons in weight from the high Sierra; and these bowlders are filled with large crystals of feldspar, some of which are more than two inches long and over an inch broad. When about half way from Independence to Camp No. 25, I noticed the ground again strewn with little water-worn obsidian pebbles.

The next day we measured a base line two miles long on the west side of the river, and noticed the whole surface over which this line extended more or less strewn with the same pebbles. In this vicinity the river runs in a narrow channel, in which the present surface of the water (May twenty-eighth) is generally twelve to fifteen feet lower than the general level of the valley to the west.

The right bank of the river here is often steep, and sometimes vertical, exposing beds of sand and gravel horizontally stratified. The left bank is lower, and a strip of low land stretches along this side of the river, covered with grass and tules, and perhaps a fourth of a mile wide, east of which all is dry and barren. West of the river, and near it, is a broad strip of dry and sandy soil; but still west of this there is a belt, which is here two or three miles in width, of good soil and good grass, reaching back to the edge of the "sagebrush slope" of the Sierra. These last details apply, of course, only to the region near Bend City.

On the right bank of the river, at the bridge, are the ruins of an old attempt at reduction works for smelting ores. A horizontal water wheel, built with buckets like those of an overshot wheel at the periphery, some india rubber belting, still in fair condition, two large arrastras, a cylindrical drum, apparently used for grinding or amalgamating purposes, a cylindrical sieve, and a roasting and smelting furnace, each of the latter about as large as a good sized cooking stove, constitute the remnants.

The Eclipse Mine is situated about seven miles southwesterly from Bend City, in the foothills of the mountains. The mill, which at the time of my visit they were preparing to build, is to be on the left bank of the river, about four miles southwesterly from the mine at the site formerly occupied by the old Union Company's mill. About a mile north of the latter point is the old Ida Mill, long since abandoned and gradually falling to ruin. The machinery still standing there consists of three batteries of four stamps each, four flat bottomed pans, two Knox amalgamators, and two wooden settling and amalgamating tubs with iron bottoms, together with boilers, a steam engine, ten-inch cylinder, thirty-inch stroke, flywheel, pulleys, shafting, etc. The old Union Mill is said to have been a ten-stamp mill with pans, etc.

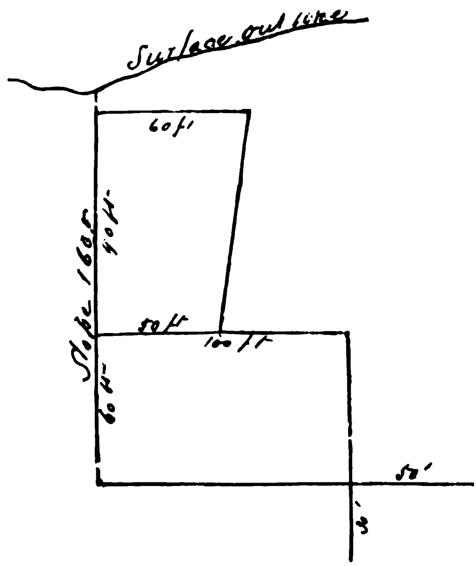
The Eclipse Mine is a vein of quartz in limestone. It strikes about north 70 degrees west, magnetic, and dips northeast about 18 to 20 degrees. The openings made are in the cañon, perhaps five hundred or six hundred feet above the valley. The outcrop does not appear very distinct to the south-

east from this cañon, but towards the northwest it is conspicuous for a considerable distance, probably for a quarter of a mile or more, across the mountain spur.

Perhaps one fourth of a mile southwest from the mine, at the very foot of the range, is a little dark-colored hill of hard crystalline rock, which appears to consist chiefly of quartz and feldspar. Next east of this hill comes a belt of slates, striking northwesterly, and dipping southwest.

Then comes the body of limestone strata, in which the mine is located. These strata are bent in a sharp anticlinal fold, whose axis runs northwest and southeast. Below, *i. e.*, to the west of the fold, the strata strike from north 30 degrees west to north 50 degrees west, and dip 50 to 80 degrees southwest. But above its axis they strike and dip with the quartz vein, which they inclose, and whose outcrop runs along the hill, just above the crest of the fold. These limestones extend some little distance up the mountains. Above them comes a broad belt of dark-colored, and probably metamorphic rock, beyond which, to the crest of the range, the rocks are gray, and from a distance look like granite.

The Eclipse vein varies from two to twelve or fourteen feet in thickness. I measured it at one point and found it between nine and ten feet. It is said to average seven feet. The mine was opened by a slope going down upon the vein, and three levels, approximately as shown in the following sketch, which is drawn in the plane of the vein.



The slope runs down along the wall of a fault, which is a large upward throw to the southeast, measuring, as stated by Mr. Eudey, foreman of the mine, three hundred feet on the surface of the hill. This wall is deeply scratched and striated, showing a direction of motion going down, or pitching, some 30 degrees to 40 degrees to the southwest, the course of the fault itself being northeast and southwest. The quartz varies considerably in character. Much of it is very cellular, filled with cavities containing crystals of calcite, etc., and considerably stained with iron. Besides free gold, it contains silver, pyrite, galena, malachite, azurite, chrysocolla, chalcopyrite, antimonial galena, gray copper, etc. Some of it contains beautiful crystals of perfectly transparent quartz, set in a very compact, opaque, and dark-colored gangue. Fine particles of free gold may be seen quite plentifully scattered through some jaspery looking specimens of the ore.

The old company which owned the Union and Eclipse Mines, and which sold the latter to the present company, used, as I am informed by Mr. Eudey, who was the Superintendent of the works, to separate their ore from this mine into two sorts, called respectively "gold ore" and "silver ore," of which the first only was worked in the mill. He stated that the "gold ore" yielded them an average of about $30 per ton, and that the

tailings from the mill used to assay from $140 to $150 per ton, in gold and silver. Their bullion was worth $10 to $12 per ounce. He says that the ore will average eighty or ninety ounces of silver per ton, besides the gold. But whether it will do so or not, the mine looked well.

At the time of my visit they were waiting the arrival of machinery from England, which, it was said, would consist, so far as its crushing arrangements are concerned, of a six-stamp mill, driven by a cam shaft, but each stamp provided with a compressed air cylinder at the top of the stem, to drive the stamp downwards by recoil, on a similar principle to that of the "steam stamp." These stamps were to be driven at a speed of one hundred and forty to one hundred and fifty blows per minute, and the six stamps were expected to crush *fifty tons* of ore per day.

The Ida and the Union Mines were not visited. The former is about a mile northwest from the Eclipse, and the latter is three or four miles southeast of it. Both of them are idle now. Mr. Eudey informed me that the Ida Mine is situated within the belt of dark-colored rock which stretches along the mountain flanks back of the Eclipse. He states that the vein, at the Union Mine, is fully as large as that at the Eclipse, and strikes about north 70 degrees west, and dips northeast, the foot-wall being slate, and the hanging-wall sometimes granite and sometimes limestone.

There must be much granite rock somewhere back of here in the mountains, as the wash from all the cañons is full of bowlders of it. What is the extent of this granite, or whether it is connected with the mass in the vicinity of the Pah Ute Monument, could not be ascertained with any certainty, as we did not climb the range at all between Mount Hahn and the Pah Ute Monument. So far as could be judged, however, from indications of the wash along the foot of the mountains, and from appearances at a distance, it would seem probable that there is a considerable mass of granite here which is very probably isolated from the Pah Ute Monument mass upon the north, as it certainly is from the mass of New York Butte to the south.

At the foot of the mountains on the east side of the mouth of Mazourka Cañon are some very dark-colored limestones, which strike about north 60 degrees west, and dip 50 degrees to 55 degrees southwest. Just to the southeast of these, and a little higher up, is a body of lighter-colored limestones, which appear to strike northeasterly and dip southeast.

Opposite the Pah Ute Monument the limestones and slates extend upwards from one half to three fourths of a mile from the foot of the mountains, with a general northwesterly strike. Above this, all is granite. At the western edge of the granite I found a considerable body of very pure, white, and coarsely crystalline, saccharoid limestone, a variety of coarse marble, of which I took specimens. The granite extends low down upon the eastern, as well as upon the western flank of the range, and must be at least four or five miles in width at this locality. The stratified rocks, which border upon it along the eastern foot of the range, appear to dip to the east. The granite itself has, in places, something of a gneissoid structure, with apparently a northwesterly strike, and a very high dip, which is sometimes southwest and sometimes southeast. The Pah Ute Monument is not far from the center of this mass of granite, which extends from here about two or three miles in both directions, *i. e.*, northwest and southeast, along the central portion of the range, whose crest throughout this distance is considerably lower than it is elsewhere. The higher masses, which form the crest immediately beyond in both directions, appear to consist of stratified rocks. But still farther towards the southeast it looks as if there might again be granite on the summit between here and Mount Hahn.

The Pah Ute Monument itself, which stands upon the very crest of the range, consists of a single solid block or pillar of weather-worn and storm-beaten granite. It has an irregularly trapezoidal base, whose length is fifty-two feet, and whose southwest end is forty-five feet, and the northeast end twelve feet wide. Its angles and the sides of the monument are irregularly rounded and smooth, and the top, which is inaccessible, is about eighty feet high.

It is not surprising, therefore, that this huge pillar, standing erect as it does upon the very summit of a narrow crest, should form so conspicuous a landmark from all points in the country where this portion of the mountains can be seen. But large as its volume is, it is but a fraction of the original block, whose fragments are strewn around its base. Many of these fragments are very large, and among them is one whose volume approaches, and whose general form resembles, that of the monument itself. This mass has cleaved from the adjacent and nearly vertical side of the present monument; and the block which formed them being thus split from top to bottom, has fallen over upon its side, and left the monument alone erect amid the ruins. All over the western slope of the range in this vicinity the solid outcrops, with the irregular patches of granitic sand between, are thickly strewn with weather-worn bowlders of all sizes. Their number is immense. Some of them weigh hundreds of tons, and their groupings are sometimes very picturesque.

I know not to what cause the origin and distribution of these bowlders can be ascribed, unless it be to differences in the texture of the granite, which in the slow weathering of the mountains have caused the softer parts to disintegrate and be removed as sand, while the harder portions have thus been loosened and freed from the surrounding mass and left to form the bowlders. Much of the rock is a well characterized granite, consisting of quartz, feldspar, and mica, with very little other mineral ingredients.

The thirtieth day of May was spent in attempting, rather unsuccessfully, to see the San Carlos and adjacent mines. Bend City and San Carlos were both of them at one time lively little villages, but now they are entirely deserted, and there is not a soul living there, nor a roof upon a house at either place. I had no one to go with me, and did not feel inclined to venture far into underground and abandoned holes alone.

At Bend City I counted the ruins of thirty-three houses, chiefly adobe, and at San Carlos twenty-six. At the latter place is an abandoned quartz mill with its machinery slowly falling to ruin. The building is about forty-five by fifty feet and built of stone. The machinery consists of a five-stamp battery, two flat bottomed pans, one large settling tub, a furnace, a tubular boiler, and a steam engine, eight by twenty-four-inch cylinder, with fly-wheel, pulleys, shafting, etc. The stone of which the mill is built is a syenitic rock obtained from the mountains close at hand. The San Carlos Mines were probably in the limestone.

But there does not seem to have ever been much mining done here. Indeed, the only thing seen at this immediate locality, deserving of the name even of an attempt at mining, was a single tunnel, probably the San Carlos tunnel, which, judging from the size of the waste pile, is probably not more than two hundred or three hundred feet long. This tunnel is in the limestone, and in the dump fine specimens of garnets may be found occurring in nodules and streaks in the limestone. I saw nothing here which looked like silver ore. This limestone (with some slates intercalated) is very much twisted and bent, its strike varying from north 35 degrees west to north 80 degrees west, magnetic, and its dip varying from near horizontality to 40 degrees southwest. Immediately to the north of this limestone, and

forming the extreme point of the mountain spur at San Carlos, commences a large body of syenitic rock, which at this locality shows no evidence of stratification, and stretches on for several miles along the foot of the mountains to the north. The southern edge of it here runs easterly, crossing the hill obliquely, and disappearing over its crest.

The stratified rocks on the south abut against syenite, which, near the line of contact, also seems to cut them here and there in little branching dikes. I did not climb to the summit of this hill. But a few days later Mr. Hoffmann did so, and he reports that at the summit, perhaps half a mile back of San Carlos, he found a small hole about fifteen feet in depth excavated in the limestone upon apparently a small deposit of rich silver ore. The strike of the limestones at this point was north 43 degrees west. Dip 30 degrees southwest.

The ore streak, which seemed to lie parallel with the inclosing strata, was about two feet wide at the surface of the ground, but at the bottom of the hole had narrowed down to about six inches. Two or three tons of good looking ore were lying by the side of this hole. Close by it, on the south, a dike of syenitic rock traversed the limestone in an easterly and westerly direction.

Towards the north, the strata were curved, striking only north 28 degrees west, and granitoid rock was not far off in this direction. All the way from San Carlos to the extreme south end of this great spur, on the west of Mazourka Cañon, the rocks consist, along the western slope of the hills, of alternating slate and limestone strata, the limestone predominating near San Carlos, and the slates towards the end of the spur. These rocks are all highly metamorphosed, though their stratification is generally perfectly preserved. The limestones vary very greatly in color; some of them being very dark, and some of the slates, etc., are almost black. In other places they are very deeply stained with sesquioxide of iron. Epidote is abundant.

About one and one half miles southeast from San Carlos is a large spur of hills, in which the strata seem to be tolerably regular, with a strike of north 45 degrees to 50 degrees west, and dip 48 degrees to 50 degrees southwest. About half a mile farther to the southeast are several quartz veins, where a little work has been done and two or three small openings made. A tunnel was started at one point, but only driven a few feet. A little southeast of this, however, a tunnel has been driven in on another quartz vein one hundred and forty or one hundred and fifty feet. This tunnel is crooked, but its general course is about north 20 degrees east, magnetic, while the strata at this point strike about north 20 degrees west, magnetic, and dip 60 degrees southwest. The quartz here contains calcite and other minerals, but no silver ore was seen. If any has been taken out from here it has been removed.

A short distance farther to the southeast, the strike and dip change again. Indeed, they are very variable, though the general rule is a northwesterly strike and southwesterly dip. At the mouth of Felta Cañon, the strata on the south side of it strike north 75 degrees to 80 degrees west, magnetic, and dip 35 degrees to 40 degrees southwest. While directly opposite, on the north side, and only a few hundred feet off, they strike about north 10 degrees east, magnetic, and dip about 50 degrees northwest. At the extreme south end of the great spur, on its west side, they strike north 85 degrees west, and dip 45 degrees southwest.

Little Butte, near Bend City, consists of an exceedingly compact, tough, and flinty siliceous rock, whose texture at the north end is nearly homogenous, but which contains more and more of a kind of cherty nodules—differing in color from the rest of the rock—as we approached the south

end. This rock is probably metamorphic, though little trace of stratification is now left. It looks as if it might have been produced from a fine clay rock containing originally more or less pebbles. It is the so called Buhr-stone, noticed in the fourth annual report of the State Mineralogist, 1884, page 320.

From camp near Bend City we made a four days' trip into the mountains, during which we followed up Mazourka Cañon to its head, then traveled easterly across the range, following Freeborn's trail, to the eastern crest, where we left the trail and climbed the Waucoba Mountains on the north. On this trip we made Camp No. 26 (about eight miles from Camp No. 25, at Bend City) on a little branch coming into Mazourka Cañon from the east, and containing small springs of water. Camp No. 27 was about seven miles above Camp No. 26, at the point where the main upper branch of Mazourka Cañon curves around to the east towards Freeborn's Pass. Near the mouth of Mazourka Cañon, on the west, are very heavy beds of limestone, resembling that seen near the foot of the mountains on the road to Cerro Gordo. This is the same limestone which contains the San Carlos Mines.

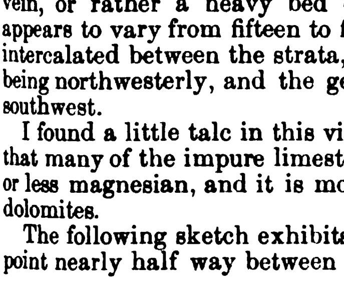
Considerable prospecting has been done about here, but there appear to have been no mining operations of any considerable extent. A number of small excavations were visited; but though a variety of minerals was noticed, such as galena, calcite, micaceous iron, pyrite, chalcopyrite, malachite, talc, quartz, etc., no distinct vein was seen, nor anything which looked like valuable ores of silver.

Next east of this limestone, and farther up the cañon, comes a broad belt of very dark-colored and highly metamorphosed sandstone, hand specimens of which frequently resemble a fine grained igneous rock. Camp No. 26 was in the eastern part of this belt.

East of this belt limestones again occur, but interstratified with much slate, generally highly altered, and some compact, flinty quartzose rock. From Camp No. 26, I climbed perhaps one thousand feet up the steep mountain slope to the east, and it was on this slope that I found the impressions of coral which, with the crinoids found near Cerro Gordo, constitute all the undoubted fossils which I discovered in the Inyo Mountains. Near the highest point which I reached here, there is an enormous vein, or rather a heavy bed of compact, barren-looking quartz, which appears to vary from fifteen to fifty feet or more in thickness, and which is intercalated between the strata, striking and dipping with them, its course being northwesterly, and the general dip 40 degrees to 50 degrees to the southwest.

I found a little talc in this vicinity, and it may be stated generally here, that many of the impure limestones in these mountains are probably more or less magnesian, and it is more than likely that some of them are true dolomites.

The following sketch exhibits a cross section of Mazourka Cañon at a point nearly half way between Camp No. 26 and Camp No. 27:



a—Hard metamorphic sandstone sometimes resembling basalt in appearance.
b—Dark blue slate.
c—Stratified, compact, flinty, quartz rock.
d—Black, jaspery rock.
e—Hard sandstones.

The strike at this point is north 35 degrees west magnetic, and the dip 50 degrees southwest. Between here and Camp No. 27 the rocks consist of

limestone, slates, and sandstones, some of the slates being exceedingly thin-bedded. In the higher ridges east of this cañon, it looks as if the prevailing rock was limestone. At and around Camp No. 27, the rock is an impure limestone, generally emitting, more or less, of a fetid odor when struck with the hammer. But a little to the northwest of here, on the way to a high hill about two miles distant, which we climbed, we meet again the eastern edge of the same belt of dark-colored sandstone, already noted in the cañon farther south. This rock is fine grained and exceedingly hard and tough, and often almost black in color. Its bedding is sometimes thin enough to impart to it a certain degree of slaty structure. The belt is wider here than it is farther south, and apparently continues on with the strata about north 50 degrees west, magnetic, for several miles beyond, running obliquely down the western slope of the mountains toward the valley. The general dip is southwesterly. The granitoid rock to the west of Mazourka Cañon does not cross the cañon at any point, and to the north also, as far as I could see, appeared to be limited and entirely surrounded by stratified rocks.

The mountains east of here for several miles are covered to a considerable extent with juniper, mountain mahogany, etc., and in places there is some tolerably heavy pine timber, but no water.

A series of snow squalls, lasting all day here, furnished us with water to drink. On traveling easterly from Camp No. 27, we found the rocks to consist chiefly of limestones with a few slates intercalated here and there. The proportion of the latter increases, however, and the sandstones also make their appearance as we approach the eastern crest of the range. At a point about a mile northeast from Camp 27, the limestones strike north 80 degrees west, magnetic, and dip 30 degrees to 35 degrees southwest. The limestone here is all dark blue in color, though much of it is filled with curious markings in the shape of little irregular whitish streaks. Much of it also shows upon its weathered surfaces indistinct markings, which look as if they might possibly once have been a mass of crinöids; but if so, all traces of structure have been since destroyed.

On reaching the saddle where the trail to Freeborn s begins to descend the eastern slope of the mountains, we found some pretty well characterized mica slate striking about north 10 degrees east, and dipping northwest. Through here, there also runs a large mass of stratified hornstone, like quartz rock, which seems to strike about north magnetic and dip westerly. These rocks abut against the granite to the north, which forms the mass of Waucoba Mountain, whose summit we had to travel rom here about four and one half miles to reach, though in a straight line, as shown by the map, it is only about three miles o

Within one fourth of a mile, or less, from where we left the trail we struck the granite. This, like that of New York Butte, is an isolated mass, but its character is somewhat different. It is generally rather a coarse grained granite, containing much mica, and also large crystals of feldspar, sometimes between two and three inches long. It also has veins, either of compact feldspar or else of exceedingly fine grained granite, running through it. All the southeastern portion of it is stratified like rather a heavy-bedded mica slate or micaceous gneiss, and its strike, for at least a mile here, is about north 45 degrees east, magnetic, and its dip 30 degrees to 35 degrees southeast. On the eastern slope of this portion of the range the rocks show but little from a distance. Wherever they could be seen, however, with a field glass, the stratified rocks in the lower part of the range appeared to have a northerly strike and an easterly dip. In Waucoba Mountain itself the granite exhibits little if any trace of bedding.

The questions whether all the granitoid rocks in this range are metamorphic or not, and what proportion of them, if any, is eruptive and igneous in origin, and what is their age if metamorphic, or what is the age of the metamorphic portion of them—all this would be very interesting if solved, no doubt. But I give it up. (1888—The writer has been informed by Mr. Wm. Crapo that since 1870, indistinct, but still recognizable fossils of both brachiopods and trilobites have been found in the Inyo Range. If this be true, everything would go to indicate that the metamorphic rocks of this range are either silurian or early devonian in origin. In other words, that they are amongst the oldest rocks ever yet recognized anywhere in the western part of North America.)

All the high peaks in the crest of the range southeast of here, and between here and the patches of granite in the region of the Pah Ute Monument, appear, so far as we could judge from a distance, to consist entirely of metamorphic rocks, chiefly limestone and slates.

As a further illustration of the detailed structure of the western slope of the range here, I give the following notes, taken on our return trip from Camp No. 27 down Mazourka Cañon. The column of figures on the left expresses the successive distances, in decimals of a mile, to hundredths, as nearly as I could estimate them by timing the rate at which we traveled:

0.00—Camp No. 27. Limestone, as already described.

0.89—Thin-bedded argillaceous limestones; strike, north 55 degrees west, magnetic; dip, 55 degrees southwest.

0.67—Very thin-bedded shales; strike, north 30 degrees west; dip, 70 degrees southwest. Belt of shales only one or two hundred feet wide. Then argillaceous limestones again. Then heavier bedded limestones.

0.40—Limestones and shales; strike, north 65 degrees west; dip, 50 degrees southwest.

0.76—Rather heavy bedded limestones; strike, north 50 degrees west; dip, 48 degrees to 50 degrees southwest.

0.13—Heavy bed of compact, flinty quartz rock, thirty-five to forty feet thick; strike, north 40 degrees west; dip, 50 degrees southwest. West of this, slates twenty feet. Then limestone forty to fifty feet. Then thin-bedded, dark blue slates, graduating into the hard, dark-colored sandstone.

0.27—Eastern edge of this sandstone.

1.61—Fork of cañon, the sandstone has in places more or less very dark blue, hard slate intercalated with it. The course of the western edge of his sandstone, in the vicinity of the west side of the cañon, between these forks and Camp No. 26, is about north 12 degrees west.

2.46—Camp No. 26.

1.56—Five hundred or six hundred feet west of the cañon, a high hill consists of syenitic granite, and belongs, perhaps, to the same patch of granitoid rocks as the hills northeast of San Carlos.

1.34—A large limestone bluff on the west of the cañon in which the dip is *easterly*. Immediately beyond comes a large body of very heavy-bedded limestone, in which the stratification is obscured.

.67—A hill on the west of the cañon, in which there is a sharp bend or twist in the limestone, from a strike of about north 35 degrees west, and a dip of 60 degrees southwest, to a strike of south 80 degrees west, and a dip of 30 degrees to the south.

2.45—Mouth of Mazourka Cañon.

0.45—Little Butte.

1.34—Camp No. 25 and Bend City.

It should have been mentioned that along the sides and broad bed of Mazourka Cañon, for three or four miles from its mouth, are extensive deposits of stratified gravel, similar in character to the broad wash from the cañon, that is spread far into the valley below, but into and through which the present stream channel (for there is no stream here now, excepting while heavy rains are falling) is cut hundreds of feet in width, to the depth of thirty-five to forty feet, and, in places, more.

On the way down from the mountains, Messrs. Hoffmann and Craven climbed to the summit of the highest peak west of the fork of Mazourka Cañon, noted above, and perhaps one half mile from the cañon. Here they were upon the eastern edge of a large body of granite, containing, at

this point, much mica, and showing no signs of any bedding. This rock seemed to form all the rest of the hills from thence west to the edge of Owens Valley, no more stratified rocks being visible from there in that direction.

Towards the east, between this point and the bed of Mazourka Cañon, the stratified rocks are considerably twisted, the general strike being northwesterly, but the dip being sometimes northeast and sometimes southwest. The prevailing dip, however, within this half mile seemed to be to the northeast. Immediately to the southwest of this point of observation is an irregular basin of moderate extent, which drains into Fleta Cañon.

Northeast of San Carlos, according to Mr. Hoffmann's observation, there is a belt of limestones and slates stretching northerly for some distance through the central portion of the hills, and separating the granite rocks near Mazourka Cañon, on the east, from the syenitic rocks, near San Carlos, on the west. How far north this belt of stratified rocks extends we did not ascertain. And, indeed, it is not certain whether all the granitoid rocks in this region, west of Mazourka Cañon, are connected together in a single mass of irregular outline, or whether they are broken up into two or three, or more, distinct and separate patches by belts of stratified rocks between.

Along the western foot of the range, and bordering the valley, however, granitoid rock extends from San Carlos northwesterly, for a distance of eleven or twelve miles, to the edge of the volcanic outbreak, a few miles southeast of Fish Springs. But this rock varies considerably in character. Near San Carlos it appears very compact and solid, while further northwest it frequently has, for a little distance, somewhat of a stratified look, which may, however, be due to cleavage.

Its mineralogical character also varies. Much of it is syenitic; but portions of it contains considerable mica, as well as hornblende, while some of it, containing very little hornblende, verges closely upon a granite. Again, in other places it contains very little of either hornblende or mica, and consists almost entirely of quartz and feldspar. It also contains, in places, considerable masses of close grained, dark hornblendic rock; and farther northwest, as we approach the volcanic outbreak, it is traversed, here and there, by irregular bands and masses of micaceous and other slaty rocks, which generally strike northwesterly and dip at high angles, sometimes one way and sometimes the other. There, also, it contains occasional veins of quartz. The color of this rock, on its weathered surfaces, varies from a rather light bluish gray, through reddish and sometimes greenish hues, to a dark reddish brown, which last is, however, the prevailing color, as seen from a distance.

Judging from appearances as seen from the valley, as well as from the bowlders which help to make up the wash from the cañons, it would seem that the higher portion of the mountains between the head of Mazourka Cañon and Owens Valley consists very largely of granitic rock, which is probably rather more uniform in character than that which skirts the foot of the range, and whose general color is a light reddish gray. But we did not climb this part of the mountains.

At, or in the immediate vicinity of the volcanic outbreak, however, the granitoid rocks in the western portion of the range suddenly terminate; and beyond here no rocks of this class were observed anywhere in the mountains until we struck the granite again high up in the White Mountains, northwest of Deep Spring Valley. It should be noted now, however, that there is a large area in this portion of the mountains which we did not actually visit at all. At the time of our trip to Waucoba Mountain from the head of Mazourka Cañon we did not go further north or northwest than

the summit of this mountain. Our point of observation northwest of Camp No. 27 was two or three miles further south than Waucoba Mountain itself; and to the north of there we did not climb to the divide or watershed of the range at any point between the head of Mazourka Cañon and the pass to Deep Spring Valley. The extent of the granitoid rocks, therefore, in the region west and northwest of Waucoba Mountain, as well as the character of the rocks generally for a considerable distance here along the crest and the central portion of the range, are more or less uncertain, and I can only give probabilities so far as the appearance from where we did go enabled us to judge.

It is probable, then, that the central portion of the mountains north of the head of Mazourka Cañon consists of stratified rocks throughout, and that the granitic mass of Waucoba Mountain therefore is entirely separated from the granitoid rocks on the west of Mazourka Cañon.

From the summit of Waucoba Mountain the granite did not appear to extend far, either to the north or west.

Again, in the region west of Mazourka Cañon the granitoid rocks, high up on the western slope of the range, do not probably extend farther to the north than they do at the edge of the valley, and these granitoid rocks are probably limited towards the northeast by the heavy belt of hard and dark-colored metamorphic sandstone observed in Mazourka Cañon, and noticed as stretching towards the northwest from our point of observation near Camp No. 27.

Furthermore, it is probable that beyond the limits thus indicated and the mass at, and in the vicinity of Waucoba Mountain, there is no granite in the range till we reach the White Mountains, as noted above.

I will now give as full a description as my notes will enable me to do of the volcanic region about Fish Springs. From the Inyo Mountains there has been but a single large outflow of volcanic matter. Its origin appears to have been a point at its upper margin in the flank of the range where there is an extinct crater, about six miles in a straight line southeasterly from Fish Springs. I did not climb this crater, but estimated its summit, which now forms the highest point of this volcanic mass, to be about two thousand feet above the level of the valley, *i. e.*, about half way up this part of the western slope of the Inyo Mountains.

From this point the lava appears to have spread in all directions towards the central portion of the valley, extending nearly to the river, and assuming thus the form of a portion of a very flat conoidal surface, whose general slope is precisely that of the wash from any one of the large cañons. In detail, its surface is of course very rough, and it would be a "hard road to travel" for saddle animals to pick their way across it. But its general slope, in all directions towards the valley, is very uniform, and is just about the same in amount as that of the sagebrush slopes that everywhere skirt the mountains.

The length of its western front towards the river is, as nearly as I could estimate by carefully timing our rate of travel across it, about three and one fourth miles. (I notice that it is incorrectly estimated on page 458 of the "Geology of California," Vol. I, at about ten miles.) It is opposite the southern portion of the series of outflows from the edge of the Sierra, which forms the much more extensive "Black Rocks" on the western side of the river.

From Fish Springs a ridge of low hills, not at all volcanic in appearance, and probably not so in reality, extends southeasterly for several miles along the right bank of Owens River. These hills, which I estimated to be one thousand feet or so in height, appear to form an outlier of the Sierra, resem-

bling the Lone Pine Hills. There appears to be nothing volcanic between these hills and the river, nor from any point which we reached could we see anything *in* them which looked volcanic, except a single unmistakable outburst in their northwestern portion.

But the Black Rocks fill the region behind them, extending up to the Sierra, and stretching beyond them in both directions, and these hills reach out almost to the river itself. The lava is generally very black in color, and in the flow from the Inyo Mountains, at least, it is usually scoriaceous on the surface. But heavy, broken masses show that a few inches beneath the surface it is very compact, and possesses a semi-vitreous luster and appearance, with conchoidal fracture.

Some of the craters are covered with loose scoriæ, forming a smooth slope, whose color is a deep and brilliant red. The statement on page 458 of the "Geology of California," Vol. I, with reference to the height at which the lava of the Black Rocks has issued from the granite, is decidedly too great. A large portion of it has issued from along near the foot of the granite and about the upper margin of the sagebrush slope. But a considerable portion of it has also issued from points still lower down upon the sagebrush slope itself. And indeed nearly all the *craters*, of which there are at least four or five well formed and prominent ones west of the river, stand far out upon the sagebrush slope, entirely away, and at distances of from one to more than two miles, from the present foot of the mountains proper. A portion of the lava has also issued directly from the granite of the mountains, entirely above the sagebrush slope. But none of it seems to have come from points at any great elevation, and the maximum height at which any of it can be found here now is decidedly less, I think, than one thousand feet above the upper margin of the sagebrush slope; say two thousand to two thousand five hundred feet above the valley. This is considerably less than "half way up the slope of the Sierra," and probably does not exceed above six thousand five hundred or seven thousand feet above the sea; while, as already stated, by far the greater portion of the lava has issued from points at lower levels.

Between the foot of the Sierra and the southern portion of the ridge of hills already noticed as running southeasterly from Fish Springs, is a volcanic cone with a crater at its summit, which, as seen from the Inyo Mountains, looks nearly circular, and beautifully regular and smooth in its outline. From this cone, a lava stream has flowed some distance to the southeast. The largest cone of all, however, is that to the northwest of Fish Springs. It stands out clear of the Sierra, its summit rising to an altitude which we estimated at about two thousand feet above the valley. It looks as if formed entirely of the materials ejected from its center and piled up around it. The lava flowed in all directions from it, and covers a large area, extending from Fish Springs to near Big Pine Creek, and from the foot of the Sierra to within a mile or two of Owens River. This mountain is visible for a long distance from both directions in the valley, as well as from the White and Inyo Mountains, and forms the most conspicuous feature of all these volcanic outflows.

The summits of almost all the cones are of a dark red color, but generally their lower flanks and all the lava streams are black. Northwest of Big Pine Creek nothing can be seen which looks volcanic from the eastern side of the valley, until we reach the vicinity of Bishop Creek.

All the lavas of these Black Rocks have a very recent appearance, and several facts seem to point to the conclusion that the date of their eruption was, in reality, so recent that since then there has been no perceptible change in the form, and, comparatively speaking, no perceptible quantity

of material added to the enormous mass of the sagebrush slopes. The lava has, so far as I could see, every appearance of having recently—and when I say recently now, I do not necessarily mean within the last one thousand or five thousand years—flowed in thin sheets over the sagebrush slopes. Its slope is generally the same as theirs, and it seems to rest upon their surface. The amount of the wash, or debris, which has, since its ejection, been spread over the surface of the lava by the channels from the cañon where they meet and cross it, is comparatively very small, indeed; and where the lava has not flowed so far as the foot of the sagebrush slopes, there are scarcely any fragments of it scattered over the general surface of the slope below to any distance from the margin of the flow. It is only in the shallow channels of the winter streams that now cross the lava, that we find its fragments carried far below, and these channels are everywhere full of them, mingled with the granitic and other bowlders that help to constitute the wash that forms the slopes.

A few additional remarks with reference to the sagebrush slopes themselves may, perhaps, not be out of place here. A short calculation will suffice to enable us to form some idea of the enormous quantity of material which they contain. If we assume that the slope at any point is three miles wide, with an average inclination of 4 degrees, and that behind and beneath it the solid granite of the eastern front of the Sierra continues down to the level of the bottom of the valley with an average slope of only 20 degrees (and it is probably steeper than this), and that the average weight of the granite debris is one hundred and thirty pounds per cubic foot, and then make the calculation for one mile in length of the slope, we shall find for a result that this one mile contains more than 2,400,000,000 tons of debris, and this is by no means an overestimate of the magnitude of the slopes for many miles along the foot of the Sierra.

The question arises—how has the material which forms these immense slopes been brought down from the mountains and distributed here? The answer must be drawn from the character of the material and the mode of its distribution. The material consists of sand, pebbles, and bowlders, the latter always rounded, as if by water or by weathering, or both. Many of the bowlders are large enough to weigh from one to twenty tons each, and are scattered far and wide over the slope, from its head against the mountains, to its foot at the lowest portion of the valley. The mode of its distribution is peculiar; it is spread out uniformly in all directions from the mouth of every separate cañon, and a longitudinal section of the surface of the upper part of the slope, running parallel with the axis of the mountains, and just clearing all the spurs, would exhibit a wavy line, with a swell in front of every cañon, and a depression opposite the point of every spur. It needs but a glance, I think, to assure us that water running from the cañons is the agency to which we must ascribe the work, enormous as it is.

It is impossible to understand how ice in any shape could have produced a distribution so uniform and of such a kind as this. Nor could the water of any lake or sea have spread the debris in such a way. Nor is it easy to see how any agency whatever could have done it while the country or valley was under water. I think, therefore, that these slopes have been built up since the valley was drained, and, in all probability, entirely by the streams from the present cañons.

But again, it is difficult to see how any continuous and steadily flowing streams could have done it. The little streams which now flow over these slopes are entirely inadequate to move heavy bowlders. They have very shallow beds, and these beds are liable to change and shift about with

every freshet from the mountains. And if a large stream were to flow over such a slope as this, it would either spread itself far and wide over the surface (in which case it also would become too shallow and weak to move the bowlders), or else, if confined in a narrow channel, it would flow on such a slope with great velocity, and would rapidly excavate the loose material of its bed, and thus quickly form a cañon, which, if the stream continued to flow, would deepen to hundreds of feet. Yet there are no cañons in these slopes, and the surface is smooth, but the *bowlders are here.*

I can account for all this, only by supposing that occasional, sudden, and very heavy floods of short duration have alternated with the constant working of the little streams to produce the result. It seems that some of these floods must have been not only sudden but of enormous volume too, to enable them, after issuing from the mountains, and being free to spread, to roll such quantities of such heavy bowlders so far out into the valley. What can have been the cause and origin of such floods I do not know. It might seem absurd to ascribe a work of so grand a magnitude to the occasional "waterspouts," or "bursting clouds," which visit this country now and then. But it has taken many long ages to form these slopes, as some facts which I shall mention hereafter will plainly show.

Another casual remark which occurs to me here, is the fact that the general inclination of the sagebrush slopes, gentle as it appears, is nevertheless somewhat greater than the maximum of the average western slope of the Sierra Nevada, taking it from the crest of Mount Whitney itself to the edge of the Tulare plain, near Visalia. From Camp No. 28, nearly opposite Fish Springs, we climbed to the top of the mountain spur which is indicated on the map as "Limestone Peak," in the Inyo Mountains. The strata in the western slope of the range here are even more contorted, twisted, and broken than at any point yet seen in these mountains. They strike and dip in every possible direction. The spurs are steep and the cañons ragged. The rocks consist of limestones alternating with talcose, argillaceous, and calcareous slates and shales, some of which weather and split into short rod-like splinters, and some of which are very thin-bedded.

The summit, to which we climbed, is all limestone. Back of this spur, however, *i. e.*, towards the east, the rocks in this region are not sufficiently exposed to enable me even to guess, from a distance, what they are, or what their course may be.

Immediately to the north and northeast from here, is the large and gently sloping amphitheater already mentioned, lying west of the crest of the range which here sweeps far around it in a great curve convex to the east. Just south of the central portion of this amphitheater, or basin, there rises from it a high, smooth, and isolated ridge. This ridge, which is entirely bare of trees, runs for several miles in a direction somewhat north of east, and leaves upon the south of it a broad and gently sloping valley, whose axis runs about north 60 degrees east, magnetic, and which, east of the ridge, merges into the general surface of the basin.

South and southeast of this valley rises the higher, and in this region the well wooded, crest of the range, which surrounds the basin. We did not visit at any point the southern or southeastern portion of this basin. But in the course of the trip, made by Mr. Craven and myself across the range to Deep Spring Valley, I had an opportunity to observe pretty well the northern and some of the central portions of it. The surface of the basin, when seen from a distance, looks rather smooth, and it has a gentle slope from the flanks of the mountains on all sides towards its central portion, while the central portion itself has a pretty uniform and still more gentle slope towards Owens Valley. The amount of the latter slope is only about

4 to 5 degrees, scarcely exceeding the average inclination of the sagebrush slopes.

All the central portion of this basin, forming a large area extending from the foot of the mountains probably three fourths of the way to the crest that surrounds it, is covered with what I take to be comparatively a very recent formation, although I found no trace of fossils to determine its age. This formation consists of stratified beds, whose strike and dip everywhere, so far as seen, are perfectly conformable to the present general slope of the surface of the basin. These beds are chiefly sand and clay, and often very thin-bedded. Here and there a little calcareous, tufaceous matter, and in places beds of gravel, may be seen. The sand varies from coarse to very fine, and in places contains much mica in thin scales. Around the upper margin of the formation, where it rests against the ancient rocks of the higher parts of the mountains, it is in many places overlaid, or rather its upper portion is formed, by beds of conglomerate varying from ten to twenty-five feet or more in thickness.

This whole formation is, in general, only just about half consolidated into rock, though thin streaks of sandstone may be found which are pretty hard; but it is generally sufficiently soft so that running water would excavate it pretty rapidly. And it has been excavated accordingly, so that instead of actually having the smooth surface which it seems to possess when seen from a distance, it consists, in reality, of a perfect labyrinth of ridges and cañons; the ridges being always steep, and often sharp and narrow, though sometimes broad-topped, while the cañons, which are also always steep and generally narrow, range from one hundred to three hundred feet or more in depth, without being deep enough to expose the bottom of the formation at any point excepting near its edge, around its upper margin.

This formation is entirely different from anything seen in the Inyo Mountains farther to the south, unless indeed it be the gravel beds of comparatively exceedingly small extent which were noticed along the sides of Mazourka Cañon. A deposit of similar appearance, as seen from the valley, extends, for a short distance only, from the mouth of this basin along the western foot of the White Mountains towards the north; but beyond there it was not seen. It seems, therefore, that it is a local formation, and from its distribution and the character and position of its bedding, it appears to have been deposited since the mountains wese uplifted, and after the basin had assumed its present form. There is no evidence, so far as I could see, of its having been at all disturbed since its deposition, except by the erosion which has formed the ridges and gulches. The beds are not contorted and have everywhere the same gentle dip of about 4 degrees or 5 degrees, excepting near the upper margin of the basin, where they are somewhat steeper. It is probably older than the sagebrush slopes, but what was its origin I do not know. Whatever were the causes and the agencies of its distribution, however, these causes have long since ceased to act; there having been no sensible addition to its mass since the commencement of the erosion, which still continues and is slowly carrying its material away and adding it to the sagebrush slope in the valley below. It is needless to add that since the climate of the country has been what it is to-day, the process of erosion itself must have been very slow indeed.

The trail which we followed from Camp No. 29, nearly opposite the mouth of Big Pine Creek, across the range to Deep Spring Valley, is laid down upon the "Map of Central California." On this trail the rocks, between the upper margin of the recent deposit and the crest of the range, are chiefly limestones, with some slates and sandstones. They do not seem along the

trail to have been so much contorted as they generally are in the Inyo Mountains to the southeast; and west of the summit here the general strike is northeasterly and the dip northwesterly. It is very likely, however, that this general trend is a comparatively local one in this part of the mountains, and that it does not extend very far either to the southeast or to the northwest of the trail.

East of the summit there is comparatively little limestone along the trail, and the rock is chiefly, and for several miles almost entirely, a very tough and hard, compact, and exceedingly fine-grained and highly metamorphosed, more or less argillaceous, sandstone or clay rock, generally very dark bluish or grayish, but frequently nearly black in color, often ringing sharply under the hammer, and breaking with a pretty smooth and large conchoidal fracture, which yields sharp and frequently thin edges. Hand specimens of this rock would be often exceedingly suggestive of an igneous origin; but it is undoubtedly metamorphic, as its stratification is everywhere preserved in remarkable perfection, and is sometimes very beautiful.

The description of Deep Spring Valley, mentioned on page 460 of the "Geology of California," Vol. I, is incorrect in two points. It is not "high up on the flanks of the White Mountain Range," nor is at all a "crater-like depression." The valley is ten or twelve miles long, and four to five miles wide, and is bordered, at least on the west and south, by mountains, which are not volcanic. And the slopes of the mountains toward the valley are not steeper, in general, than the slopes of the White and Inyo Mountains are elsewhere. The valley, so far as we saw, is a desert, producing nothing better than sagebrush, except in its southern corner. It has its slopes or "washes" from the mountains, and resembles nothing else, in its general appearance, so much as it does a hundred other valleys that are scattered through the country east of here. The barometer here stood about one inch lower than it did in Owens Valley.

In the southern corner of the valley there is a sort of lagoon, which, at the time of our visit here, consisted of a moderate area of shallow water, surrounded by a much larger area of more or less soft and muddy soil, covered with a thick and widespread incrustation of white salts. The valley has no outlet, and the water that forms this lagoon comes, in summer, from copious springs which issue along the foot of the mountains, just southeast of the lagoon. The water, as it issues from most of the springs, is good and pretty pure, and it waters a considerable area of most luxuriant grass, before it finally reaches and loses itself in the saline waters of the lagoon.

From Camp No. 30, at these springs, we climbed to a point of observation in the mountains on the south, not far from two thousand feet above our camp. For two thirds of the height to which we here climbed the rocks are micaceous slates and hard, dark-colored, fine-grained sandstones, the latter containing much mica in very fine scales and also considerable epidote. Above this comes a narrow bed of limestone, then the sandstone, etc., again, then limestone, then sandstones, and then a heavy mass of flinty quartzose rock. All these rocks strike northwesterly and dip northeasterly, generally about north 40 degrees to 50 degrees west, magnetic, the dip being 40 to 50 degrees northeast.

This was the severest climb for the animals during the whole trip. The dark, basaltic-looking sandstone seems to have a peculiar tendency to break into angular fragments, whose edges, being both sharp and very hard, are exceedingly severe upon the feet of animals that travel over them. The summit which we reached here was not quite so high as some others to the east and south in the same range. So far as could be seen, all the rocks in this region appear to be stratified.

In the range of mountains beyond Antelope Valley and perhaps twenty to twenty-five miles a little south of east, magnetic, from here, the strata are finely exposed and run apparently with perfect regularity for many miles, and seem to strike northwest and dip northeast. In the White Mountains, west and northwest of Deep Spring Valley, the strata appear to be bent and twisted, but look as if a northeast strike and a gentle northwest dip were common.

Rabe says he saw granite in the mountains a mile or so to the east of Camp No. 30. The varying positions of the strata in the region of the pass are such that it is hardly possible to exhibit to the eye a satisfactory section of the range from Owens Valley to Deep Spring Valley. I therefore give the following notes instead, which I think will convey a better idea of the detailed structure of the range here than any sketch could do.

These notes begin at our Camp No. 30 in Deep Spring Valley, and proceed southwesterly along the trail across the range, the figures on the left being the successive distances in decimals of a mile, as estimated by timing our rate of travel, it being about four miles and a half from Camp No. 30 to the mouth of the cañon where the trail enters the mountains:

3.50—On the sagebrush slope, about two miles northwest of here, is a cañon, the northeast side of which the strata strike northwest and dip northeast; while on the opposite side of the same cañon they strike northeast and dip gently northwest. Also in a mountain about three miles southeast of here, the strike is apparently northeast, but the dip southeast.
1.08—Mouth of cañon.
0.27—A narrow belt of alternating slates and limestones; strike, north 15 degrees west, magnetic; dip, 48 degrees northeast.
0.43—Slates; strike, north 15 degrees west, magnetic; dip, 30 degrees northeast.
0.54—Slaty sandstones; stratification rather obscure, but apparently strike north 55 degrees west, magnetic; dip, 30 degrees northeast.
0.48—Hard bluish rock; strike, north 80 degrees west, magnetic; dip, 30 degrees northeast.
0.59—Hard, blue, fine grained, conchoidal sandstone; strike, north 80 degrees west, magnetic; dip, 35 degrees northeast.
2.05—Hard, bluish gray, fine grained sandstones; strike, north 80 degrees west, magnetic; dip, 20 degrees northeast.
0.16—Hard, dark bluish, conchoidal sandstone.
0.54—Fine grained, hard sandstone, conchoidal in fracture, but lighter in color.
0.16—Summit of Pass. Limestone, heavy-bedded; stratification not well exposed at this point.
0.48—Limestone; strike, about north 80 degrees east, magnetic; dip, 25 degrees to 30 degrees northwest.
0.16—Limestones; strike, about north 20 degrees west, magnetic; dip, 30 degrees southwest.
0.11—Limestones; strike, north 80 degrees east, magnetic; dip, 25 degrees to 30 degrees northwest.
0.11—A bed of compact, impure, flinty quartz rock, with more or less of a slaty structure intercalated in the limestone; strike, north 80 degrees to 85 degrees east, magnetic, and dip about 25 degrees northwest.
0.11—Sandstones and slates alternating; rather thin-bedded.
0.21—Rather heavy-bedded limestones; strike, north 70 degrees east, magnetic, and dip 20 degrees northwest.
0.59—Limestones; strike, north 50 degrees to 60 degrees east, magnetic; dip, 30 degrees northwest.
0.48—Ferruginous limestones; stratification obscure; edge of recent deposit in "basin."
3.45—Camp No. 31. The rocks in the mountains northwest of here, all the way, seem to be sandstones and slates.
2.50—Foot of mountains. Lower edge of "basin formation," and head of "sagebrush slope," at eastern margin of Owens Valley.
4.00—Camp No. 29, opposite Big Pine Creek.

All bearings given in my notes are, without exception, magnetic, unless otherwise stated.

The distances given above, it must be remembered, are approximately the distance which one *traveled*. But the trail being crooked in the mountains, the distances in a straight line are considerably less.

At the summit of the pass we stopped and climbed the crest of a hill, about three fourths of a mile to the north, where Mr. Craven took some bearings. This hill consists of a hard, dark bluish, conchoidal sandstone. The stratification is here somewhat obscure; but the strike appears to be about north 75 degrees east, magnetic, and the dip, 20 degrees northwest. This rock contains considerable magnetic iron distributed through it in fine grains. And it may be stated here that the similar rock already described as forming so large a portion of the eastern slope on the Deep Spring Valley trail, together with that to be hereafter mentioned, which possesses the same general character, and occurs in large quantity along the crest of the White Mountains for a considerable distance to the northwest, frequently contains more or less of these small particles of magnetic iron.

On leaving this point we continued on and climbed another still higher summit, about a mile further to the northwest, and at this point I made the following observations: The rocks here consist of alternating beds of impure slaty quartz rock and metamorphic shales; strike, north 30 degrees west; dip, 32 degrees northeast.

From here the limestone noticed at the summit of the pass appears to form a belt stretching easterly along the northern slope of the ridge to the south of Deep Spring Valley, and bearing gradually downwards toward the valley. The upper portion of this ridge, to the east of the pass and above the limestone, seems to consist of the dark metamorphic sandstones.

But towards the east these sandstones cease on the crest of the ridge, and bear gradually down its northern slope towards the valley, while beyond and above them comes another broad belt of what appears to be limestone, which also bears obliquely downward towards the valley. Then comes a series of strata, which look like alternating slates and limestones, and appear to graduate into the rocks which form the northern slope at the point where we climbed this ridge from Camp No. 30.

In a hill, which bears about three miles north 7¾ degrees east from the station we are now on, the strata seem to strike northeast and dip northwest. Towards the west and southwest, for a distance of two or three miles, the hills appear to consist of highly metamorphic slates and sandstones.

At a point about two miles south 73 degrees west from here, the strata seem to strike northwest and dip southwest.

Late in the evening of June eleventh we made Camp No. 31, at the point already indicated, in a little cañon of the basin formation, where are some little springs of water.

On the morning of the twelfth we traveled easterly seven or eight miles up the mountains across the series of ridges and cañons constituting the northern portion of this basin formation, and climbed a high crest on its northern margin.

This mountain is probably some four or five miles to the southwest of the nearest point in the watershed of the range. It consists of alternating slate and limestone beds, which, in places, are considerably bent and twisted, but whose general strike ranges from about north 10 degrees east to north 20 degrees east, magnetic, and the dip 50 degrees to 60 degrees southeast. From here, the upper margin of the recent formation, which skirts the foot of this peak, runs west, magnetic, about two miles, curving then to the north, and in the opposite direction it runs south 40 degrees east for about three miles.

In a hill about two miles a little east of north from here the strata seem to strike northwest and dip northeast.

This twelfth of June was a showery and squally day. At sunrise in the morning a heavy mass of clouds lay low in the southwest, behind the crest of the Sierra. These clouds rapidly approached, crept over the summit of the Sierra, and settled far down their eastern slope, then crossed Owens Valley and the Inyo Mountains, bringing lively thunder squalls, with wind and some rain, and on the higher points a little hail and snow. It began to rain where we were at 2 P. M., and rained a little at intervals from then till night. But the quantity of rain which fell was small. As this finishes the details I have to present with reference to that portion of the range which I have called the Inyo Mountains, I now make the following general remarks:

We have seen that by far the greater portion of the Inyo Mountains consists of stratified rocks, highly metamorphosed, and generally crystalline. The unstratified rocks, though covering considerable areas, form a much smaller percentage of the mass of the mountains. These rocks are universally either granitoid or porphyroid in texture. The proportion of the porphyroid rocks is quite small, and they seem to be chiefly, if not entirely, metamorphic. With reference to the granitoid rocks, their origin seems to be involved in much uncertainty, portions of them suggesting strongly the idea that they, too, may be to a greater or less extent metamorphic.

Of the stratified rocks, limestones, which vary indefinitely in the amount of impurities which they contain, and which may be, to a greater or less extent, dolomitic, constitute a very large proportion. But their distribution is very irregular. They are almost everywhere interstratified to a greater or less extent with the slates and sandstones throughout the range. But the great mass of them, which forms alone so large a portion of the southwestern slope of the range, near Cerro Gordo, although it continues to form the foot of the range for a distance of probably twelve or fifteen miles, seems gradually to thin out as we proceed northwest, and at the point where we descended the range, from near Mount Hahn, but little limestone is to be seen. The mass of heavy-bedded limestone, also at the summit of the range, in which occur the mines at Cerro Gordo, does not appear to extend to any great distance to the northwest without becoming more or less irregularly split up and interstratified with slates and other rocks.

In the country about the head of Mazourka Cañon is a very heavy mass of limestone strata, and it is not improbable that the whole crest of the range for a considerable distance between the Pah Ute Monument and the Waucoba Mountain, and east of the upper part of Mazourka Cañon, may consist chiefly of limestone.

There is also a heavy body of it on the Deep Spring Valley trail, and other masses of greater or less extent are scattered through the range. But I could discover no definite general law which seems to regulate the distribution of these heavy bodies of strata which consist almost entirely of limestones; and, so far as my observation extended, no single body of such strata can be traced uninterruptedly for any great distance through the mountains without becoming more or less broken up and intermingled with other rocks. With reference to the stratification and relative position of the rocks, these have been everywhere too much and too irregularly distributed to make it safe to draw many general conclusions from them without far more detailed study than I was able to give them.

As a rule, it is indeed true that the general strike of the rocks in the southwestern slope of the range is northwest and southeast, and the dip southwesterly. But besides the endless exceptions which may be every-

where found to this statement, if the rocks are taken in minute detail, there are one or two notable exceptions upon a larger scale, particularly the one at the southeast end of the range, where a very heavy mass of strata, forming the lower portion of the mountains between Cerro Gordo and Owens Lake, has a northeasterly dip. Whether this mass of strata has been overturned, or whether, in connection with the rocks to the east of it, it forms a great synclinal fold, or whether, indeed, its position may not be due to some other movement, I do not know, nor do I think it safe to judge.

Throughout the range the dip of the rocks, in whatever direction it may happen to be, is generally high—much oftener over 45 degrees than under it. It appears, moreover, that no distinct anticlinal axis can be definitely traced throughout the range; at least, none which corresponds with the present topographical axis of the range, or (which is nearly the same thing) with the general axis of the granite outcrops.

Near Cerro Gordo the strata upon the northeastern slope of the range, as well as on the upper portion of this southwestern slope, appear to dip southwest; and in the vicinity of New York Butte, the general dip still seems southwest for some distance to the east of the granite, which here forms the crest. A few facts, however, which were given among the rest in the preceding description of the range, have led me to suspect that there may, perhaps, be a sort of anticlinal axis commencing near the eastern foot of the range, somewhere between Cerro Gordo and New York Butte, and running northwesterly in a direction oblique to the axis of the range, gradually climbing to the crest at some point not far northwest of Mount Hahn, or the Inyo Peak, and thence continuing on northwesterly across the granite region of the Pah Ute Monument towards the peaks which form the crest to the east of the head of Mazourka Cañon. But this is by no means certain; and to the west and north of Waucoba Mountains, I have altogether too little information respecting the crest and the eastern slope to enable me to trace out any system in the stratification.

Mid all the irregularity, however, and frequently the apparent confusion of the rocks in the Inyo Mountains, and mid all the uncertainties with reference to many important points, one general fact at least is evident and certain: There is an intimate connection between the general stratigraphical positions and relations of the rocks, and the general features of the topography of the range. This is shown, not only by the fact that throughout the southern portion of the range, the most frequent strike of the rocks is approximately parallel with the axis of its topography, but also by the general tendency to an easterly and westerly trend, with a northerly dip, which was observed about the pass to Deep Spring Valley.

And it may be noted here that the general position of these strata appears to be somewhat curved and convex to the north, the general strike on the northeastern slope being somewhat to the north of west, while southwest of the summit it is oftener to the south of west, magnetic. There is evidently some connection here between this general position of the strata and the irregular curving and branching of the crest of the range, and the sending out of the subordinate ridge, which lies southeast of Deep Spring Valley, and separates it from Antelope Valley. It would probably, however, be a difficult matter to trace such a connection far into the more detailed structure of the range. The only volcanic rocks in the range, so far as I saw, were the few dikes noticed traversing the limestones near Owens Lake, and the outbreak on the western flank, southeast of Fish Springs.

With reference to mining matters in the Inyo Mountains, the examples of San Carlos and Bend City prove nothing, one way or the other. The

early history of mining enterprises here was one of extravagance and want of knowledge, to say nothing of the hostility of the Indians, who then infested the mountains and the valley. The Eclipse Mine looks well; Cerro Gordo is prospering, and I know of no reason why the Inyo Mountains should not yet furnish considerable silver.

On the fourteenth of June we broke up Camp No. 29, opposite Big Pine, and proceeded up the valley to Camp No. 32, two or three miles beyond Owensville, and nearly opposite Bishop Creek.

The distance from camp to camp, by the odometer, was twenty-one and seventy-two one hundredths miles, and in the course of the day I made the following notes, the successive distances from camp to camp being estimated by timing our rate of travel:

6.63—Opposite Black Mountain, which is high, and has a roundish top, and rises abruptly and steeply from the east side of the valley, and in which the strata strike northerly, or east of north, and dip easterly at angles varying, apparently, from 30 degrees to 45 degrees. The upper part of this mountain seems to consist entirely of very dark colored sandstones and slates. The lower portion, which is of a lighter color, is, very probably, limestone, the outcrop of which continues for some distance to rise higher on the slope of the mountains, as it goes towards the north.

1.98—Opposite the mouth of a large, deep, and steep cañon in the White Mountains, in the large wooded crest seen through this cañon, and lying back of the first, or nearest crest, the strata seem to strike northeast and dip southeast at a gentle angle.

The summit, and all the upper portion of the nearest crest or ridge running northerly from this cañon, consists of a heavy body of dark-colored metamorphic sandstones and slates, striking northerly and dipping easterly.

Next below these, on the western slope, comes a belt of lighter-colored rocks, probably limestones. And below these, all the lower portion of the flank of the range, from a height estimated at twelve hundred to fifteen hundred feet above the valley, down to the head of the "sagebrush slope," is covered with what appears to be a portion of a perfectly similar deposit to the recent one which fills the amphitheater or "basin" in the northern part of the Inyo Mountains, a few miles to the southeast. The average slope of this lower portion of the mountains is pretty steep; perhaps 20 degrees or so. But these recent beds appear to have the same gentle inclination towards the valley here as further to the southeast, and lie on the mountain sides in a succession of shelves, which present their broken edges towards the valley.

This formation stretches on some distance to the north, and probably covers the foothills of the mountains, to a greater or less height, for something like half a dozen miles from this cañon, beyond which it was seen no more. But the bench-like faces of the edges of the beds do not extend more than half this distance from the cañon. All the northern portion of this formation (if, indeed, I am not mistaken in supposing it to be the same thing) has been degraded into a series of smooth and apparently gravelly, though pretty steep, slopes.

2.90—Opposite rather a sharp peak, which forms, so far, the culminating point of the ridge running north from the large cañon noted above. About half way between the cañon and this peak, light-colored rocks, probably limestone, come in on the crest of the ridge, and descend slowly the western slope on going northerly; the belt of dark-colored rocks below them gradually thinning out, and for a mile or two nearly disappearing.

1.93—Opposite the mouth of a cañon from which comes a large "wash," containing bowlders of granite as well as metamorphic rocks. Just to the north of this cañon the dark-colored rocks which had nearly disappeared, begin again in the shape of a wedge, which gradually widens out for two or three miles northerly, and then continues on in more or less irregular streaks, whose lower edge for several miles is nearly straight and horizontal, and perhaps eight hundred to one thousand feet above the valley. All the rocks towards the summit here, so far as can be seen, are lighter colored. Their general strike seems northerly, and their dip easterly.

5.61—Owensville. Another utterly deserted village, consisting of the ruins of some twenty or twenty-five houses, more or less. The houses were built of the material of the volcanic table land to the north, which is soft, and cuts easily; and the village is said to have been built by a mining excitement, though I saw no mines, nor any ores, and only a very few little prospecting holes in the mountains to the east.

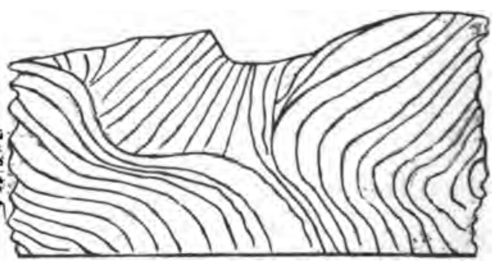
2.72—Camp No. 32, on the left bank of Owens River. It must be remembered that all the preceding notes of this day's travel are based only upon the appearances as seen from the valley, and give the best judgment of the facts which I could make from such a distance—nothing more. A few green spots, rare and very small indeed, just large enough to be visible, scattered here and there along the foothills, show that springs exist along here, and that water is not so scarce as in the Inyo Mountains.

To the north of Big Pine Creek, the sagebrush slope of the Sierra diminishes rapidly in width and magnitude.

Opposite a point a little to the north of the Black Mountain, the eastern front of the Sierra makes a sharp bend, and from here to Mono Lake its general trend is far more to the west of north than it is to the south of here. Towards Bishop Creek the valley thus rapidly widens out, while at the same time a larger proportion of its surface is good and arable land.

On the seventeenth of June we attempted to reach the summit of the White Mountains, taking the fourth large spur to the north of Silver Cañon. In the cañon next north of this spur was a little stream. From Camp No. 32 to the foot of this spur the distance was about five miles, and from here we climbed about six miles up the mountains. Finding then, however, that the road between us and the summit was exceedingly rough and difficult, with no prospect of water ahead for the animals, we were obliged to turn back. I made, however, the following notes on this trip, the successive distances from the foot of the mountains being estimated by timing our rate of travel:

0.00—Foot of mountains. Rocks at this point not exposed. Slope gentle for some distance above here.
0.66—Foot of steeper slope of mountains. Talcose slates; strike, north 75 degrees west, magnetic; dip, nearly vertical. Just above here, on the hill to the right, is an old shaft eighteen or twenty feet deep on a streak of ferruginous quartz, with several other little prospecting holes near it, but no promising ore was visible.
0.16—Slates: strike, north 80 degrees west; dip, 60 degrees to 70 degrees southwest.
0.59—Slates; strike, north 50 degrees to 60 degrees west and stand nearly vertical.
0.49—Throughout this last distance the rocks are all slates, generally talcose and argillaceous. The strike ranges all the way from west to northwest. The dip is always high, and often vertical, but oftener southwest than northeast. At the end of this distance, however, we find a band of limestone, which strikes about north 50 degrees west and dips southwest, and beyond here limestones alternate with slates and sandstones, the slates becoming gradually less talcose and more argillaceous, and the strike becoming apparently somewhat more regular, generally approaching about north 50 degrees west, the dip being near the vertical.
0.66—Calcareous slates; strike, north 40 degrees west; dip, nearly vertical.
0.33—A projecting ridge of slates and hard sandstones, which strike north 40 degrees west, the dip being northeast, but very near the vertical.
0.49—Slates and limestones; strike, north 70 degrees to 75 degrees west; dip, northeast, but nearly vertical.
0.66—At this point I made the accompanying sketch, exhibiting the foldings of the strata in a hill bearing about half a mile north 30 degrees west from here. Beyond here for some distance the rocks are chiefly slates with more or less sandstone and only occasional beds of limestone.



0.98—A heavy bed of limestones; strike, from north 40 degrees west to north 60 degrees west, magnetic, and dip nearly vertical, but oftener southwest than northeast.
0.98—Slates; strike, north 50 degrees west, and dip, 50 degrees to 60 degrees southwest. This is the highest point which we reached here, and is at the western edge of a heavy mass of limestone strata.

On the nineteenth, we again tried the White Mountains, taking the next spur south of the one we had tried before; and this time we succeeded better, and made Camp No. 33, near the crest of the range.

The distance traveled from Camp No. 32 to Camp No. 33 was estimated at fifteen and one quarter miles, distributed as follows, and with the following notes taken on the way:

0.00—Camp No. 32.
4.25—Foot of mountains; rocks not well exposed.
0.56—Slates; strike, about north 25 degrees west; dip, 70 degrees to 75 degrees northeast.

1.12—A little prospecting hole (no ore) on a vein of quartz in slates, which strike north 20 degrees to 25 degrees west, and dip 50 degrees to 60 degrees northeast.
1.58—Red and thin-bedded slates; strike, about north 20 degrees west, and dip, 25 degrees to 30 degrees northeast. Then comes a thin belt of hard, blue, metamorphic sandstone.
0.11—Western edge of a heavy outcrop of limestones.
0.26—A belt of alternating slates and limestones.
0.30—All limestone.
0.94—A narrow belt of slates.
0.19—A narrow belt of very thin alternating layers of limestone and shale.
0.19—Thin shales; strike, north 45 degrees west; dip, about 45 degrees northeast.
0.19—The dip, which hitherto has been northeast, has grown rapidly steeper, and is here a little to the southwest of the vertical. From here on, the dip is generally to the southwest, and limestones, slates, and shales continue to alternate for a couple of miles.
2.25—A very heavy body of very thin shales; strike, north 15 degrees to 20 degrees west, and dip about 60 degrees southwest. Above here the dip is constantly southwest, to Camp No. 33.
1.31—Climbed a high point just south of our trail, and found myself on the crest of the ridge west of Silver Cañon, which is here deep and steep. This crest consists of slates and shales. We had to travel north in order to cross this cañon near its head.
1.00—Bed of upper part of Silver Cañon. Rocks here, limestone. From here we traveled a little east of south, to Camp No. 33.
1.57—Western edge of a high ridge consisting of very hard and dark-colored metamorphic slates and sandstones.
0.43—Camp No. 33.

From here we climbed to a point of observation bearing south 10 degrees east, about three fourths of a mile from camp. This peak consists of slates, which strike about north 30 degrees west, and dip 50 degrees southwest.

The next day we traveled from Camp No. 33 about seven miles northerly to Camp No. 34, and took some observations from a limestone peak just north of the latter camp.

On the twenty-first, while Mr. Hoffmann took observations from the crest of a high peak of dark-colored sandstone about one and one fourth miles northwest of camp, I traveled three or four miles farther north, along the crest, until I reached the southern edge of a large body of granite, which, from here, stretches several miles farther north towards the White Mountain Peak. On the twenty-second we returned to Camp 32 in the valley.

To the eastward of Camps 33 and 34 the range spreads out in a somewhat extended area of mountain top, which consists of a sort of labyrinth of peaks and sharp and narrow ridges, with winding gulches and cañons between.

The ridges have generally a northerly or northwesterly trend, and they, as well as the peaks, consist either of limestone or else of a very compact, hard, and dark-colored sandstone, which perfectly resembles that already described on the eastern slope of the range at the Deep Spring Valley Pass. This sandstone is generally very fine grained, and often graduates into a similar, but slaty, rock. It frequently contains magnetic iron. It has a strong tendency to break in hard, angular fragments, with sharp edges, and some of the slopes of the ridges are a perfect talus of such loose fragments, almost from top to bottom, for hundreds of feet in height.

These slopes as seen from a distance, of course, look perfectly smooth, but they are in reality utterly impassable for any horse or mule, and it is delicate business picking one's way over them on foot, for besides the hardness and the sharp angularity of the fragments which compose them, the slopes are as steep as such loose fragments can lie, and the latter are ready to roll or slide at the least provocation. A fresh fracture of this rock is very dark in color, but has usually something of a bluish tinge. Its weathered surfaces are often, though slightly, tinged with dull deep red. But the hills which it forms, when seen from a little distance, appear of a uniform

dull and very dark brown, almost a black. Wherever sandstone is mentioned in what follows, with reference to this immediate vicinity, this is the kind of rock intended, as no other variety of sandstone was seen here.

At a point of observation southeast of Camp 33 (called Fire Peak in Mr. Hoffmann's notes), I made the following notes, confirmed by my later observation: The peak bearing north 27 degrees 52 minutes east, about two and one half miles, is limestone. The one about two and one half miles north 1 degree 10 minutes west is sandstone, and is the one whose southwest foot we touched on the way up to Camp 33. The three peaks or ridges whose crests bear, respectively, about four and one fourth miles north 21 degrees 12 minutes west, six and one half miles north 27 degrees 37 minutes west, and eight miles north 32 degrees 53 minutes west, are all sandstone. The second one of these three was Mr. Hoffmann's point of observation of the twenty-first, and was the highest point which we reached in the White Mountains. A peaky mass bearing about nine miles north 19½ degrees west is also limestone. The peak or ridge bearing about six and one half miles north 23 degrees 13 minutes west has a limestone belt running through, what appears from here, its central portion, while its flanks are sandstone. This peak is a little north of Camp No. 34, and but a few hundred yards northwest of the point of observation of the twentieth of June. The sandstone forming its eastern flank is but a narrow belt, and east of it the rocks are again limestone. The White Mountain Peak is about fourteen miles distant, and has much snow near its summit.

So far as can be seen from here, the strike in this vicinity is generally northerly. On the crest of the low ridge, however, immediately northwest of Camp No. 33, and between it and Silver Cañon, the slates appear to lie nearly horizontal, with a very gentle dip to the northwest. There was no water anywhere near Camp 33. On leaving Camp 33, we climbed first to the summit of the sandstone ridge, which bore two and one half miles north 1 degree and 10 minutes west from Fire Peak. About one half mile due east of here is the western edge of a considerable mass of granite. This granite forms rougher but lower hills east of the sandstone. The weathered surfaces of some of this sandstone are covered with irregular markings, which suggest a possibility of crinoids or fucoids. But these are very indistinct, and, if they were once fossils, all traces of internal structure are obliterated.

Camp No. 34 was among the snowbanks, and the peaks near it are the highest ones in the range southeast of the immediate vicinity of the White Mountain Peak. Mr. Hoffmann's point of observation of the twentieth of June, close by Camp No. 34, is limestone, which strikes about north 80 degrees west, and dips 30 to 35 degrees southwest. This limestone contains, in places, considerable tremolite, in radiated bunches of white crystals. It also contains scattered crystals of actinolite, and, in places, short crystals of green hornblende, besides spots and streaks of crystalline hornblendic rock. Within a radius of two or three miles from this point, from northwest around by east to southeast, the rocks appear to be almost entirely limestone, some of it being shaly and some very compact, some of it dark colored and some nearly pure white, and all crystalline.

Beyond Cottonwood Creek, to the northeast, the rocks all look like a sort of gneissoid granite, with a northwesterly strike and nearly vertical dip, and very extensively capped by layers, probably twenty-five to one hundred feet thick or more, of a very dark colored and basaltic looking rock, which is probably volcanic. From the point mentioned on page 204, where granite was first observed in this region, its western edge appears to bear northeasterly to Cottonwood Creek, and then northwesterly along the side of its

deep cañon, thus leaving this triangular or semicircular area of limestone to the west of it, and southwest of Cottonwood Creek.

Mr. Hoffmann's point of observation of the twenty-first (one and one fourth miles northwest of Camp 34) and everything along the crest of the range for three or four miles to the northwest is sandstone to the edge of the granite. Some of this sandstone is full of small particles of magnetic iron. I traveled northwest along the crest to the edge of the granite. At this point a sort of saddle, several hundred feet lower than the average height of the range on either side, stretches entirely across its crest in a direction north 50 degrees east, magnetic, marking the southeastern edge of this mass of granite and its line of contact with the other rocks.

This granite, as already noted, extends several miles northwesterly towards the White Mountain Peak. The cañon running southwesterly from this saddle appears to follow nearly a straight course to the foot of the mountains. The one running northeasterly appears to continue only two or three miles in this direction, and then to bend southeasterly towards Cottonwood Creek. From the crest of the saddle, as far as can be seen towards the southwest and for about a mile towards the northeast, everything southeast of the granite is sandstone. But northeast of the sandstone the rock adjoining the granite is limestone, which, as seen from here, appears to strike northeast and dip southeast, though portions of it, as seen from another point, appeared to dip northwest.

Beginning at a point about two and a half miles southeast of Camp No. 34, the course of the western edge of this limestone region is about north 45 degrees west for some three miles and then about north 30 degrees west for perhaps three or three and a half miles more to the southeast edge of the granite as just described. Thence it borders the granite, running about north 50 degrees east, perhaps a couple of miles, and then crossing the cañon at the bend, a narrow belt of limestone appears to continue on to the northeast across the granite ridge beyond. But southeast of this bend the limestone does not appear to cross the deep cañon.

In the little belt of limestone flanked by sandstones, already noted just northwest of the point of observation of the twentieth, the strata strike north 70 degrees to 80 degrees west, and dip 25 degrees to 30 degrees southwest. This limestone, too, is full of tremolite. In the sandstone ridge, which bears north 65 degrees 53 minutes west from point of observation of June twenty-first, the strata, as seen from the east at a distance of about a quarter of a mile, appear to strike north 40 degrees east and dip about 50 degrees southeast.

From the most northerly point here reached on the crest of the range the White Mountain Peak itself does not appear to be granite, its colors being too much variegated and too strongly marked with red, dark brown, and dirty white, etc. The mass of granite between it and the saddle which I reached seems to stretch only about half way down the western slope of the range, all the lower portion of this slope, as afterwards seen from the valley, appearing to be stratified rocks. From Camp No. 32, granite looking outlines were noticed again on the crest of the range, north of the White Mountain Peak.

At Camp No. 32, on the twenty-third of June, Owens River was nearly level with the top of its banks, being thirty-five to forty feet wide, probably eight to ten feet deep, and flowing about four miles per hour. Owens Valley, from the southern bluffs of the volcanic table land on the north of Bishop Creek to the north end of Owens Lake, is about sixty-five miles long, and I estimated that it probably contains not far from one hundred thousand acres of good grazing land; but almost the whole valley between

the sagebrush slopes might be readily irrigated, if desired, from the river itself, with no greater difficulty than the expense it would involve, since the river has sufficient fall to give it a pretty rapid current throughout its whole length, in spite of its extreme crookedness, and the area which might thus be made productive would probably be several times that which now produces grass.

On leaving Camp No. 32, we followed the stage road through the long and narrow valley which skirts the western foot of the White Mountains, lying between them and the volcanic table land to the west. The sagebrush slope or wash from the White Mountains fills the greater portion of this valley, extending much of the way entirely across it to the very edge of the volcanic country. From the west there is nothing whatever to be seen in the White Mountains themselves which look volcanic. But the bluffs terminating the table land north of Bishop Creek and the great bend of Owens River form the southern edge of a broad volcanic region, which fills, not simply the greater part of the country between it and the White Mountains and the Sierra as far northwest as Mono Lake, but which stretches on through and to the eastward of the latter, connecting uninterruptedly with the country around Aurora, and in the vicinity of the Lonora Pass, climbing to the crest of the Sierra itself, and merging in the great volcanic belt which covers so much of the more northern Sierra.

But it is not true that all is volcanic in the region bounded by the Sierra and the White Mountains, and by Mono Lake, Adobe Meadows, and Owens Valley. Many of the hills and ridges west of the White Mountains and southwest of Adobe Meadows consist of granite, and their aggregate area is large. Yet volcanic material is scattered almost everywhere, and over by far the greater portion of the region nothing else is visible. Indeed, so far as I could judge this region, it appears to consist almost everywhere of a granitic floor, through which the volcanic material has issued and over which it has spread. Nearly every large cañon on the western slope of the White Mountains had a small stream of water flowing from it at the time of our trip. But most of these streams sank in the sagebrush slope, a few only being large enough to cross it and reach its foot.

A few miles northwest of Owensville there is in the bottom of the narrow valley a little lagoon, with a considerable area of green and watered soil around it. It is said that this locality used to be entirely dry, but that two or three years ago some men cleaned out a channel from one of the cañons, and that since then the water, which before then used to sink, has flowed on across the slopes and formed this little lake where tules grow. Previous to reaching this lagoon, I visited the southeast corner of the volcanic table land and took some specimens of its material, which seems to be a mass of somewhat consolidated volcanic ash. It is a soft rock, can be easily cut and dressed with edge tools, and was used for many of the houses at Owensville. Some of the houses at Bishop Creek are also built of it. It is, however, not very good material, being soft and not very strong.

I found the same material again at the mouth of the long, straight cañon which runs southeast through the volcanic table land, and empties into the narrow valley through which we traveled, a few miles to the northwest of the little lagoon, and here it was in *columnar forms*. The columns are as perfectly developed as any basaltic columns I have ever seen, only not divided transversely into blocks, as basaltic columns frequently are. They are straight, nearly vertical, often five or six feet in diameter, and estimated thirty to thirty-five feet high as exposed in the bluff, their lower portions being hidden by their own debris and the material of the bed of

the dry watercourse at their foot. The number of their sides varies from three to seven or eight, the most common numbers being four, five, and six. Their faces are often curved (concave outwards), and their edges generally pretty sharp. A fresh fracture of their material shows a light reddish-gray rock, of very low average specific gravity, and extremely porous. It has also a sort of brecciated appearance, containing large quantities of broken angular bits of pumice distributed through it, without apparent order, and with their fibrous cells pointing in every direction. It also contains crystals of what I suppose to be glassy feldspar, distributed rather plentifully and uniformly through it, and occurring, to all appearance, with perfect indifference either within the bits of inclosed pumice, or scattered through the rest of the material which forms the rock. This rock, in detached blocks, rings like phonolite under the hammer; yet the mass is not hard, and as already stated can be easily cut with edge tools, and very easily crushed to powder with the hammer. A fresh surface of it feels exceedingly rough to the touch. I could see no difference in its texture in different parts of the columns. It is just as light and porous near the foot of the bluff as it is near the top.

And it may be added here that the whole of this extensive table land, so far as I saw it, consists of essentially the same material, which varies within rather narrow limits in hardness and shade of color, but whose general character and peculiar texture are everywhere the same.

Over the tops of the columns at this particular locality are spread what appeared to be several horizontal beds, aggregating not many feet in thickness, of apparently similar material, but in which the columnar structure is only very partially developed. This is, however, the only appearance of bedding which was seen anywhere in this table land.

The southern portion of this plateau, where the line between Inyo and Mono Counties crosses it, is some ten or twelve miles in width. And this is only some two or three miles north of its extreme southern edge. Beyond the county line, the same plateau stretches northwesterly some fifteen or eighteen miles farther, rising gradually higher and higher on the mountain flanks in that direction, thus covering a broad area of many square miles in the southeastern part of Mono County. Through almost the whole length of the southwestern side of this plateau, Owens River has excavated for itself a deep and very narrow gorge, through which it runs. The geography of the whole region is well shown on the southeastern quarter of Whitney's unfinished "Map of Central California."

The plateau itself is very sharply outlined and bounded on all sides by vertical bluffs, which everywhere exhibit more or less perfect columnar forms.

The observations immediately following were made by the writer in July, 1873:

From the first large cañon to the north of Cottonwood Cañon, running from the Sierra to Owens Lake, there came down in January, 1867, as I am assured by Ned Reddy and Mr. Taylor (and present appearances well bear out their statement), a great landslide, or mud flow. Some say that this was caused by a waterspout; others, that it was caused by long continued rains. At all events, it appears to have come down the cañon with a rush; an immense mass of semifluid mud, sand, and bowlders, which flowed a quarter of a mile or more from the foot of the mountains out over the sagebrush slope and even into the lake. A man who was riding horseback is said to have been caught in the flow. The man barely escaped with his life; but the horse did not, and was overwhelmed. So far as can be judged from present appearances (1873), the area of the slopes covered

by this flow was nearly equivalent to that of an equilateral triangle of one thousand feet on each side, buried ten feet deep. But no man knows how much more ran into the lake at that time. Many heavy bowlders probably went into the lake, and many, which would exceed ten tons each in weight, were carried far out towards the foot of the slope. This case shows that these landslides, or mud flows (whether due to water spouts, or only to long continued rains), coming suddenly from these high and steep mountains with great velocity, do in fact distribute their materials in exactly the same manner as that in which the great mass of the sagebrush slopes themselves is distributed; and that these sudden occasional rushes alone are fully capable of having built up the greatest part of these slopes (vast as they are), *if* only *time enough be given.* And *who shall measure geological time by years?*

The fact that earthquake phenomena must always be a matter of great interest to dwellers on the Pacific Coast; the fact that Professor Whitney has been accused of never having published anything concerning the great earthquake of March 26, 1872, in Owens Valley; and the fact that the numbers of the "Overland Monthly" for August and September, 1872, in which the following articles from Professor Whitney's pen appeared, are now practically out of print and hard to get, suffice to justify their reproduction here in more permanent and more easily accessible form:

THE OWENS VALLEY EARTHQUAKE.

In Two Papers. I. Local Details.

The earthquake of March 26, 1872, having been more disastrous in its effects than any which have taken place on the Pacific Coast, north of Mexico, since California became a part of the United States, has naturally attracted much attention, and has been much written and commented upon. The distance of that part of the State where the most violent disturbances took place from the ordinary routes of travel, is such that few, except those residing there, could see for themselves what had actually happened; and it is quite natural that exaggerated stories should have been put in circulation, when the truth itself was so remarkable. The exigencies of the geological survey work requiring that a party should pass through Owens Valley to reach the field of their labors, occasion was taken to inquire and observe, as carefully as time would allow, into all the principal facts connected with this earthquake; and the following pages contain a plain statement of the results obtained, with such few comments as the space at our command will allow us to append. It must be borne in mind, however, that the region where the greatest disturbance occurred is one which is very thinly inhabited; and that the buildings which existed there at the time of the shock were of a kind most unsuitable for the preservation of a serviceable record, in the form of fractured walls and the like, for a future examination by the scientific observer. Hence, the results obtained are less satisfactory than might, perhaps, have been expected, or than they would have been in a thickly settled region, over which large and well built edifices had been erected. Still, a number of valuable facts have been observed, and some general conclusions can be drawn with safety from the data collected.

To understand what follows, it will be necessary to devote a few lines to a sketch of the geography and geology of Owens Valley, since it is a region but little known, even to Californians, and quite a *terra incognita* to the ordinary reader. And yet, it is certainly one of the most remarkable por-

tions of a remarkable State; and it is safe to assert that it will, at no distant period, attract many visitors. For its position is almost, if not quite, unique in respect to the attractions of its scenery, among all the valleys of which our ample territory has the right to boast.

It is traversed by the river of the same name, which rises in that remarkable knot of mountains which head the Merced, the Tuolumne, and the San Joaquin, and of which the dominating summits are Mount Ritter and Mount Lyell—two peaks which are very conspicuous from Mount Hoffmann and other high points around the Yosemite Valley.

After leaving the mountains, Owens River runs first through a large, secluded valley, lying some thirty miles, a little to the east of south, from Mono Lake, and called Long Valley. Leaving this, it makes its way through a volcanic table land, in a deep, precipitous cañon, from which it emerges and enters Owens Valley proper, bending its previous easterly course into an almost southerly one. After running some seventy miles in a south southeast direction, it empties into Owens Lake, where it becomes lost by evaporation, like all the other streams in the Great Basin, on the western border of which Owens Valley lies.

Both sides of the valley are bordered by extremely steep and elevated mountains, by which it is closed in, as if by two gigantic walls. On the west is the Sierra Nevada, with no pass across it of less than twelve thousand feet in elevation; the crest of the range broken into a thousand pinnacles and battlements, and rising to from fourteen thousand to fifteen thousand feet above the sea level, and from ten thousand to eleven thousand feet above the valley itself, which, at Lone Pine, is about four thousand feet above tide water. The eastern wall is formed by the range of mountains called the Inyo, in the southern part of the valley, and the White Mountains, further north; for this chain, double in name, is in reality a unit. The Sierra wall of the valley is, in fact, the eastern edge, or face, of a great mass of mountains, from seventy to a hundred miles in width, intersected by numberless deep cañons, the divides between which are crested with domes and pinnacles—forming a vast labyrinth, whose recesses remain yet to be explored, and to disclose scenes of grandeur and beauty rivaling those presented by the Alpine chains.

The Inyo and White Mountain range, on the other hand, is one narrow crest, almost unique in its narrowness and steepness. It rises very precipitously from the valley to a height of from eight thousand to eleven thousand feet above the sea, or four thousand to seven thousand feet above the plain at its foot. Dark, somber, destitute of trees and water, and rarely whitened with snow, even for a short period, it presents a most striking contrast to the Sierra side of the valley, down which the snow masses extend, at least—at this time of the present year—for a distance of from five thousand to six thousand feet vertical, and whose melting feeds the numerous and copious streams which make the valley habitable.

At Lone Pine it is only eighteen miles across, from summit to summit of the ranges, the bottom, or level portion of the valley, being two or three miles in width. On the Sierra side there extends from the base of the precipitous portion of the range a long slope, gently descending, at an angle of five or six degrees, covered with sagebrush, and made up of coarse detritus from the mountains behind, a vast pile of bowlders, gravel, and sand, two thousand feet thick at the upper end, and spread out at the foot of the range in a belt of varying width, which, in some places, is as much as six or seven miles. Just where this belt of detritus, or "sagebrush slope," meets the valley bottom, the mountain streams lose their torrential character, and, finer sediment being deposited, there is a growth of vege-

tation somewhat meadow-like in character. It is on this fringe along the edge of the sagebrush, which, however, is not continuous, but rather in patches opposite to the great cañons from which issue the numerous streams referred to above, that the small settlements in the valley are exclusively located.

The geology of Owens Valley is as interesting as its scenery is grand. The two great ranges which inclose it are not of the same geological age, nor are they at all alike in structure or lithological character. The Sierra is chiefly one vast mass of granite; indeed, this is the only rock visible from the south end of Owens Lake north as far as the thirty-seventh parallel, which crosses the valley about nine miles north of Camp Independence.

The interior of the chain, between the parallels of 36 degrees 30 minutes, and 37 degrees, is also all granite so far as we know. This granite has been elevated since the Jurassic period, and belongs to the Sierra Nevada system of upheaval. The Inyo and White Mountain range, on the other hand, is much more ancient, being a part of the great palæozoic formation, which occupies so extensive an area in the Great Basin. The mass of these mountains, instead of being made up of granite, consists chiefly of limestone, sandstone, and other stratified materials, tilted up at a high angle, and with the most complicated system of strike and dip.

Midway in the valley, commencing at a point about thirty miles north of Lone Pine, and extending for ten miles, there is a region of volcanic cones and lava flows, by which the river is crowded over against the Inyo range, at the foot of which it has just room to flow. These cones are seemingly as perfect as they ever were, and the flows of basalt have spread themselves out over the sagebrush slope in a manner wonderfully indicative of a recent date for their outbreaking. Yet all is now absolutely quiet. The volcanic forces are dormant. Further up the valley, however, especially after the river bends to the westward, and when we reach the volcanic table land, spoken of before, and which forms a vast plateau south of Mono Lake, there are abundant indications of former volcanic activity, in the usual form of solfataras and hot springs.

So, too, south of Owens Lake, in the mountains which lie east of the Sierra, and which are known as the Coso Range, are numerous cones, from which long, dark streams of basaltic lava may be easily traced down into the valley, where they spread out into great tables. As we debouch from Walkers Pass we see the Coso Mountains off to the northeast, and the basaltic cones and flows offer a curious contrast of color with the light-colored granitic rocks, forming the mass of the range, from which the volcanic masses have issued; so that it was hard for us to convince ourselves for some time that these dark spots were not the shadows of clouds resting over the landscape.

We have, then, in this region, all the elements of geological disturbances—a narrow valley, which was probably once a chasm of immense depth, between two stupendous ranges of very different geological ages; and volcanic cones and lava-flows, which have issued from the interior of the earth since the detrital slope at the base of the Sierra was formed. The gigantic character of the forces which have been called into play is evident on every hand, and the observer, even if no geologist, cannot fail to become impressed with the idea that the fabric of the earth must have been shaken to its very center, while these stupendous features of its surface were in process of development.

Such being, as sketched above in a few brief words, the character of the region where the earthquake of March twenty-sixth last was most severely

felt, we will proceed to a statement of some of the most striking facts therewith connected.

The comparison of the various telegraphic reports to the newspapers published in California shows that at about half-past two o'clock on the morning of March 26, 1872, a shock of an earthquake was felt over nearly the whole extent of the State, or from Shasta to San Diego County, north and south, and through its whole breadth, with the exception of the extreme northern and northwestern portion. It appeared, further, that a large part of the adjoining State of Nevada was also violently shaken at the same time, the disturbance having reached nearly to its extreme eastern border, and as far south as any place from which information could be obtained by telegraph or newspaper. It also appeared, as soon as the news could arrive from that quarter, that a portion of Mexico had been similarly disturbed on the same day, and other nearly synchronous shocks and volcanic disturbances are now known to have taken place in different parts of the world, as will be noticed farther on.

At present we have to do only with the shocks of the twenty-sixth and the following days, and their effects in California. These shocks were destructive in Owens Valley only; but they were severe along the western slope of the Sierra and in the foothills from Visalia to Sonora, more moderate farther north, and quite moderate in the Coast Ranges and on the west side of the valleys of the Sacramento and San Joaquin. Large areas of country over which they were undoubtedly felt with severity are almost entirely uninhabited, so that only very fragmentary information will ever be obtained from these quarters.

All the statements from different places agree in this: That the first shock felt was sudden, and by far the most violent of all, and that the serious damage done was everywhere effected within the first minute or two of the commencement of the disturbance. But the shocks continued to be felt in various localities, with occasional intermissions from the morning of the twenty-sixth of March during a considerable part of that day; and in Owens Valley the ground had not resumed its usual condition of tranquillity at the time of our leaving, which was the twenty-third of May. Along the settled portion of the Sierra Nevada, as far north as Placer County at least, the shocks were repeated at intervals from about half-pas two until about half-past six of the morning of the first great shock; and about half-past six a quite severe oscillation occurred, which was particularly noticed at many points in the mining counties from Mariposa to Oroville, and which was also felt in the Coast Ranges.

Throughout the western slope of the Sierra Nevada, in the mining belt, the disturbance of March twenty-sixth was the most severe ever experienced since the region was settled by the whites. But the fact that the loss of life was confined to Owens Valley, turned the attention and sympathy of the public almost exclusively in that direction. Before attempting to draw any general conclusions, or to go further into details with regard to extent and magnitude of the earthquake disturbances of the twenty-sixth of March and the following days, outside of Owens Valley, we will first give such facts as were observed and collected in that particular region.

As Lone Pine and Independence are the places where most of the damage to life and property was done, it will be desirable to describe their position. They are both at the edge of the sagebrush slope, before noticed as a peculiar feature of the valley. They are both on the west, or Sierra side of the river. Lone Pine is about six miles north of Owens Lake, and Independence about fifteen miles farther in the same direction. Camp In-

dependence is about three miles above the town of the same name, and Bishop Creek about forty.

All persons concur in stating that the first shock (which took place about half-past two) was by far the most severe, and that all the serious damage was done by it. The estimates as to the duration of the destructive shock are very discordant; and this is not to be wondered at, when we consider how men's thoughts were occupied at the time, and how little suited the conditions were to precision of statement. From a variety of considerations, it seems reasonable to infer that the most violent portion of the disturbance may have lasted fully a minute, and possibly as much as a minute and a half. The subsequent disturbances, although occasionally violent enough to displace furniture and throw goods off the shelves, were of little account as compared with the first oscillations. A second heavy shock occurred in Owens Valley, between six and half-past six o'clock; and this was also (as mentioned above) very distinctly felt over a large portion of the State. Many persons spoke of the vibrations as being almost continuous between the first and second great shocks.

There appears to have been no one in the valley who kept, or tried to keep, a record of the phenomena from the beginning. Mr. Seth G. Sneden, of Bishop Creek, however, began on the thirty-first of March to note down the principal vibrations, although without any special attempt at accuracy in reference to the time of their occurrence. From his memoranda it appears that hardly a day had passed, from the beginning of his record up to the time of our visit, May twenty-first, without some oscillation having been experienced, and there were usually several during each twenty-four hours. On the whole, however, the evidence of the gradual slackening of the action of the internal forces was very clear, there being nothing more than slight vibrations in the month of May. Quite a heavy shock was felt on the night of May thirteenth at Lone Pine, which was also very sensible to us at Little Lake, a point fifty miles south; but at Bishop Creek, the same distance to the north, it was not noticed.

To our party, traveling from Visalia, by way of Walkers Pass, to Owens Valley, the destructive effects of the earthquake began first to be visible at Indian Wells, about sixty-seven miles nearly due south from Lone Pine. Here the walls of the adobe house were badly cracked, and some adobes had been thrown from the north gable a distance of fifteen feet toward the north. The house, which has walls nearly two feet in thickness, is traversed, in several places, by vertical cracks from top to bottom. Two very heavy shocks were felt here on the morning of the twenty-sixth of March.

At Little Lake, nineteen miles further north, the house, which is in part very loosely built of cobble stones, was badly injured, and a portion of it shaken down. At Haiwee, eleven miles above, a stone barn, built of hewn blocks of volcanic ash, was entirely overthrown, and the materials piled promiscuously together. A person who slept inside escaped with his life by a truly extraordinary chance. The wooden house at the same place, although violently shaken, was almost entirely uninjured. Loose articles within were thrown violently from their places, and generally toward the east. At Olancha, at the foot of Owens Lake, the adobe house was not thrown down, although badly cracked on the east and south faces, and not at all on the north side. Articles in this house were thrown to the northwest. Three miles further north, at Big Lake House, an adobe building was almost destroyed, the north and south sides having suffered the most damage. The rubbish was thrown chiefly to the north, and some of it as far as fifteen feet from the side of the building.

At Lone Pine we found ourselves in the midst of a scene of ruin and disaster—giving a vivid idea, even after the lapse of two months, of the distressing scenes through which the inhabitants had passed. This town contained from two hundred and fifty to three hundred inhabitants, living almost exclusively in adobe houses, every one of which, and one of stone—the only one of that material in the town—was entirely demolished. Twenty-three persons were either killed outright, or found dead when disinterred from the ruins; four more were so badly injured that they have since died, and some sixty others were more or less seriously hurt, some of them very severely, so that their recovery seems, indeed, remarkable. One person was killed at the Eclipse Mine, and a child near Camp Independence. These are all the fatal cases; and it is, indeed, wonderful that the loss of life should have been so exclusively limited to the vicinity of Lone Pine, since the destruction of all buildings of adobe and brick at Independence was nearly as complete as it was at Lone Pine itself.

At Fort Independence, which was entirely built of adobes, but in a very strong and substantial manner considering the material, the destruction was almost entire; and yet, strange to say, only one man was injured, and he but slightly. It would appear that the smallest and most poorly built houses were those in which the inmates suffered the most.

From Olancha to Big Pine, a distance of about sixty miles, the force of the shock seems to have been about equally severe, as far as one could judge from its effects in fissuring the earth; but the proportion of adobe houses diminishing as we go north, in consequence of lumber becoming more accessible and cheaper in that direction, the destruction of life and property was proportionally diminished.

The almost universal testimony of the residents of Owens Valley was to the effect that the shocks came from the Sierra Nevada, and from that portion of the range which lies between Owens Lake and Independence. In the region to the south of the lake the vibrations were felt as approaching from the northwest. At Lone Pine they were referred to the high mountains in the immediate vicinity to the west, and as we moved up the valley the direction assigned was always more to the south of west as we proceeded north. This agrees also with our own experience; for in the shocks which we felt in various points between Little Lake and Bishop Creek, we all agreed in referring their origin to the region of the Sierra lying to the west of Owens Lake and Lone Pine.

We were not able to discover that any person had been awakened by sounds preceding the first great shock; it seems to have been the motion, accompanied by noises, in all cases, which aroused the sleepers. And the impressions made, in the same locality even, by these sounds on different persons, seem to have been quite varying in their character and degree. Some described the noise as resembling that made by a whole park of artillery, shot off in rapid succession, with the rattling of musketry between. Others were much impressed by the noises made by different kinds of animals. The barking and howling of the dogs, and the lowing of the cattle, were strangely intermingled with the reverberations of the falling rocks in the mountains, the creaking of the timbers of the wooden buildings, and the rattling and crashing of the loose articles contained within them.

In regard to the character of the subterranean noises accompanying the earthquake shocks in this region, we learned something from our own observations. Of the various disturbances of the ground which we experienced between Little Lake and Bishop Creek, several were distinctly preceded by a dull, explosive sound, like the noise of the firing of a piece of heavy artillery at a great distance, or the letting off of a heavy blast. These sounds

were distinctly heard as coming from the region of the Sierra Nevada, and were, in most cases, followed by a tremor of the ground, after an interval of from two to five seconds. In several cases the explosive sounds were heard by our party when no subsequent vibration was perceived. But most of the shocks which followed these sounds were so light that they were not usually felt except by persons who were at rest. Almost without exception, the oscillations noticed by us were in the night; no doubt the same disturbances took place in the daytime; but to persons moving about, in a wagon, or on horseback, as we were most of the time, they were imperceptible.

Mr. Sneden's record, kept at Bishop Creek, mentions these explosive sounds as frequent; and it is noticeable that at that place the sounds frequently occurred without any attendant shock, and also that they appear usually to have followed, instead of preceding, the vibrations. Thus, the record says: April fifteenth and sixteenth, "explosions during the night, but no shocks;" April twenty-fifth, 1:30 A. M., "shock, followed by numerous explosive reports;" April twenty-ninth, "shock, with explosive reports following." And, during the whole month of May, the term "explosive reports" appears frequently in the record, while that of "explosive shocks," or shocks accompanied by explosive sounds, is only rarely used. In some cases the sounds are noted as having been very loud and distinct.

Among the geological effects of these disturbances we may notice: Fissures in the soil or rocks; alterations of level of different parts of the valley, either temporary or permanent; changes in the watercourses; accumulations of water where such were not before known, and similar occurrences, which prove that the wave left a permanent record of its passage.

As before remarked, the ranches and settlements in the valley are chiefly at the lower edge of the sagebrush slope, on the alluvial patches, where the soil is soft and springy, and permeated by moisture from the mountain streams. As would be expected, it is just at this line of junction of two different formations that the geological effects of the earthquake are much the most distinctly marked. All the way from Haiwee Meadows to Big Pine Creek we met frequent cracks in the earth, areas of sunken ground, depressions partly filled with water, and regions where motion of the surface soil had taken place, either in a vertical or horizontal direction. The direction of these fissures is almost always nearly parallel with that of the base of the mountains, although in a few instances they run diagonally across the valley. The dependence of the fissures upon the character of the soil was well exemplified at Haiwee Meadows, which occupy an oval area somewhat less than a mile in diameter, surrounded by hills, all around the border of which the soil is wet and heavy owing to the presence of numerous springs in that position. Along this border the ground is broken by fissures, and the inside edge has settled as much as four or five feet. The hills to the east of the meadows are of volcanic sediment; and, on visiting them, a large crack was observed running in an easterly direction across one of the spurs, which looked fresh, as if it might have been made during the recent earthquake.

At Olancha numerous fissures were noticed, and between them, at one place, the ground was depressed two or three feet for a width of forty feet. Passing up the west side of Owens Lake, the cracks became more numerous, and great depressions between them were seen, where the ground had sunk from two to ten feet, over a space from ten to a hundred feet in width, and for a length of several hundred yards; the depressed areas almost always nearly coinciding in the direction of their greatest longitudinal extension with that of the base of the mountains. On this side of the lake,

which occupies almost the whole width of the valley, the fissures are mostly on the sagebrush slope, about half way between the shore and the base of the Sierra, the slope being here about two miles in width. In some places, however, the cracks are quite near the edge of the lake.

All along in the vicinity of Lone Pine, and at the base of the Alabama Range of foothills, which here extend up the valley for the distance of about eight miles, forming a sort of detached outlier of the Sierra, and composed of similar granitic and metamorphic rocks; the fissures are numerous, and here and there they form a perfect network, between which the ground has become raised or sunk, so as to be quite impassable. Similar phenomena were seen at various points in following up the valley; but nowhere are the effects of the earthquake in fissuring and depressing the surface so manifest as in the vicinity of Big Pine. A large body of water issues from the gorges of the Sierra west of this place, and this water spreads out after leaving the sagebrush slope, and runs in numerous channels through a low and swampy meadow, several hundred acres in extent. Here there is a series of extensive fissures, which may be traced uninterruptedly for several miles. In one place an area of ground, two or three hundred feet wide, has sunk to the depth of twenty or thirty feet in places, leaving vertical walls on each side, and these depressions have become partly filled with water, so that ponds have been formed of no inconsiderable size. One noticed was fully one third of a mile in length, and would have been much larger had not the depression been so situated as to afford partial drainage of the area at one end, so that the basin could not be entirely filled.

In all cases, the character of the disturbances of the soil seemed to be pretty much the same, namely: The depression of narrow belts between fissures running nearly parallel to the course of the Sierra, and chiefly limited to the edge of the sagebrush slope. There are also cracks across the spurs of granitic rock in the foothills of the Sierra, in a very few places; but in no case did we observe any relative displacement of the two sides of the fissure. Numerous irregular and star-shaped cracks occur in the low ground near the river's edge, as would naturally be expected.

While the distribution of the water in the valley is not essentially different from what it was before the earthquake, there are quite a number of localities where slight changes have taken place. The river itself, which is deep and swift, and from sixty to eighty feet wide, opposite Lone Pine, is said to have been dry along that portion of its course for several hours after the first heavy shock. This is stated on what I believe to be trustworthy authority, Captain Scoones, of the Eclipse Mine, among others, testifying to this fact. This may be easily admitted, when we consider the great number of fissures opened in the valley, and how greedily they would have absorbed the water in their vicinity. At the bridge southeast of Lone Pine, the disturbance of the water in the river, at the time of the first great shock, was so severe that fish were thrown out upon the bank; and the men stopping there, who were engaged in building a boat, did not hesitate to capture them, and served them up for breakfast in the morning—a quite novel method of utilizing an earthquake.

The tidal wave produced in Owens Lake (which is a body of water about seventeen miles long and ten wide in its widest part) is represented, by those living at Swansea, on its northeastern border, as having been very striking. The family of our informant was awakened by the fearful noise, and, on rushing out of the house, found that the water had receded from the shore, and that it stood in a perpendicular wall lengthwise of the lake—that is, north and south—where it seemed as if a number of different cur-

rents were contending with tremendous fracas for the mastery. Of course, the family were greatly alarmed, fearing that when the wave came back to the shore it would be with a violence that would sweep everything away, the region bordering on the lake being here so flat that all escape by runing to higher ground seemed impossible. The wave, however, returned to the shore, in the course of two or three minutes, breaking and flowing some two hundred feet beyond the former edge of the shore, but doing no essential damage.

There has been a slight permanent depression of the soil at the northwest corner of the lake, and a corresponding rise on the northeast side. This is proved by the fact that the lake is a little shallower at the Swansea landing than it was before the shock; while the water has risen on the opposite side, so that the road has had to be changed from its former course and carried higher up on the slope. The vertical displacement, however, would probably not exceed two feet. We could gather no evidence of any change in the shore of the lake at other points.

There are several places in the valley where fissures in the ground have crossed roads, ditches, and lines of fences, and where evidence has been left of an actual moving of the ground horizontally, as well as vertically. One of these instances of horizontal motion is seen on the road from Bend City to Independence, about three miles east of the latter place. Here, according to a careful diagram of the locality, drawn by Captain Scroones, it appears that the road running east and west has been cut off by a fissure twelve feet wide, and the westerly portion of it carried eighteen feet to the south. The same thing was noticed by us at Lone Pine and Big Pine, with regard to fences and ditches, the horizontal distance through which the ground had been moved varying from three to twelve feet. These are local phenomena, however, and not to be taken as indicative of a general motion of the valley in any fixed direction.

Among the various effects of the earthquake, the noise and crash of masses of rock falling or rolling down the slopes and in the cañons of the mountain ranges was one of those most frequently mentioned as extremely impressive, and we ourselves had abundant opportunities of verifying these statements. Although our wanderings took us through but a very insignificant part of the mountain gorges, still we saw numerous places where large masses of rock had evidently been recently dislodged, and had rolled down the slopes of the cañons, loosened from their foundations, no doubt, by the recent earthquake.

Just above Bishop Creek, on the edge of the lava plateau, a mass of rhyolite, of a bulk of two hundred cubic yards, had been thrown down, close to the road, and split in two. The noise and dust made by these masses of sliding and rolling detritus were described by all as among the most striking phenomena of the earthquake. Many persons also testify to having seen streams of fire accompanying these masses in their descent, and which can hardly have originated in any other way than from the friction of the moving materials. When we consider that the rock of the Sierra is granite, and that it, in many places, decômposes with great irregularity, so as to leave many great bowlder-like masses of harder material projecting above the general surface, which are all ready to be started on the downward track by a violent jar, it will be easily understood that a vast amount of material might be set in motion by a heavy earthquake shock. Still, we were often surprised by seeing great overhanging rocks which looked as if they might almost be dislodged by a push with the hand, and which had evidently stood firm against the recent convulsions.

Although it is true that there is a great cluster of extinct volcanic cones midway in Owens Valley, between the lake and Bishop Creek, and a great volcanic plateau all about the upper portion, yet just in the region where the earthquake was most severe, or between Olancha and Independence, there is nothing but granite on the Sierra side, while the Inyo Range contains no volcanic rocks. It is not true that any extraordinary indications of volcanic activity were perceived in Owens Valley during or since the disturbances of March twenty-sixth. Even the cones near Fish Springs seem entirely extinct, there being no solfataric action about them. The nearest points where such indications of former volcanic activity are now perceptible are in the Coso Mountains, about twelve miles east of Little Lake, and in Round Valley, twelve or fifteen miles west of Bishop Creek. The reports of fires having been seen in the mountains after the earthquake, some of which are said to have lasted as much as half an hour, seem to be well authenticated, but these fires cannot have had a volcanic origin. It is not unlikely that the friction of the falling masses of rock may, in places, have set fire to the sagebrush, although we saw no indications of anything of the kind in our explorations, which, however, were necessarily over a very limited area, compared with the whole extent of the mountain sides visible from the valley.

A few words may be added in regard to the effect of the earthquake on domestic animals, all of which exhibited unmistakable signs of the most dreadful alarm. Bands of horses were dispersed, and scattered far and wide over the mountains. Cattle are said by several persons to have uttered the most pitiful sounds, indicating terror. Dogs sought protection from men to whom they were strangers, and whom they would have been more likely to attack at an ordinary time. In short, the panic among the brute creation was sufficient to indicate that they had no slight appreciation of the fact that a great catastrophe was impending. Some cattle were squeezed to death in the fissures, it is said; and it is also stated, on what seems good authority, that some were found dead without any apparent cause. It is possible that fear, or overexertion, caused by fright and the desire to escape from the scene of danger, may have been the real cause of the death in such cases; at all events, this seems more likely to have been the case than that animals should have perished from the inhalation of noxious vapors emitted from the ground, as has been suggested by some persons.

THE OWENS VALLEY EARTHQUAKE.

In Two Papers. II. General Conclusions.

In the preceding paper, some local details of the phenomena of the earthquake of March 26, 1872, have been given, and especially the facts observed in Owens Valley. It now remains to extend the area of our observations somewhat, and also to inquire what general conclusions can be drawn from them with regard to the nature and origin of the forces there displayed on so grand a scale. But first it will be desirable to give, in simple language, and as concisely as possible, some idea of what earthquakes really are, and what seismologists are aiming to find out with regard to them. Anything like an exhaustive discussion of the subject would, of course, be out of place in a popular magazine, lack of space being of itself sufficient reason for not entering into any details. But it may be possible to give in a few words some better idea than people usually possess—judging from the character of the contributions to our daily journals on this and kindred subjects—of

what is already well established in regard to this class of phenomena, and also of the direction in which further research is desirable.

An earthquake is the passage of an elastic wave of motion through a portion of the crust of the earth. All have some idea of the nature of wave motion, although but few have taken the pains to make themselves thoroughly acquainted with the subject. All know that sound is propagated by wave motion; that light is wave motion. Everybody has observed that if a stone be dropped into still water, the impulse will make itself manifest in a series of waves extending in all directions from the point where the stone came in contact with the water, and gradually dying out in advancing from that point. There is no one who does not know that, when he feels the jar of a heavily loaded wagon passing through the streets, the shock of the wheels against the paving stones has been communicated by a wave motion through the pavement and the ground into his body. The tremulous motion of a building, caused by the passage of heavy vehicles, has often been mistaken for the effect of an earthquake; and vibrations caused by real earthquakes have frequently passed unnoticed, because so slight that they could not be distinguished amid the noise and jar of a crowded street.

Quite severe shocks of earthquakes have occurred in San Francisco, alarming people so as to cause them to rush into the streets, while persons riding in the street cars felt nothing unusual. The explosion of a nitro-glycerine factory near San Francisco, a few days ago, was thought by many to be a first class earthquake; the shock being felt for miles in every direction, the windows rattling and the walls shaking, although in a more sudden and jerky way, than they usually do when the disturbance comes from deep down in the bowels of mother earth. It is evident that we have only to imagine an impulse given, like that produced by the nitro-glycerine explosion—only on a vastly greater scale—to produce all the effects of the most disastrous shock.

The general character of earthquake shocks being thus easily understood, it is evident that the investigation of them, with all their attendant phenomena, belongs partly to the geologist and partly to the physicist. A great earthquake is an historical event of importance in proportion to its magnitude and the locality of its occurrence.

A severe convulsion might take place in an entirely uninhabited region, and thus have no special interest to any but the scientific investigator. But if the scene of the event was laid in a thickly populated country, so that cities and towns were destroyed, and thousands of the inhabitants killed, then the occurrence would become part of the world's general history, and have a significance entirely distinct from its scientific aspect.

The scientific investigation of earthquake phenomena has two distinct sides to it—the physical and the geological. All that relates to the mechanics of these occurrences—such as the method of transmission of the wave through rocks and soils; or media of different densities; the velocity of such transmission, and the effect in fracturing and displacing objects on the surface—comes within the scope of the physical investigator. These phenomena are all governed by regular laws, and are to be studied with the aid of mathematical science, just as other physical phenomena are.

The results of earthquakes, on the other hand, as manifested on the surface by changes in its condition, have a geological bearing, for they throw light on the long series of events by which the earth has assumed its present condition. Hence the student of geology is especially interested in these events and in the permanent record which they leave behind; and this interest is the more profound because these investigations

connect themselves directly with some of the most interesting and difficult questions of geological science. From the study of earthquakes we are led directly to that of volcanoes and volcanic phenomena, and from these to the structure and mode of formation of mountain chains and continents.

For a long time in the world's history earthquakes were looked upon as mysterious occurrences—awful warnings sent by a higher power to remind us of or punish us for our sins—and the idea of investigating them scientifically never occurred to any one.

When the thoughts of men began to be turned toward the cycle of changes which the earth has undergone—in the very first dawn of that science which is now known as geology—the changes which have been wrought, and which are and have been all the time taking place through the agencies of the volcano and the earthquake, strongly excited the imagination of numerous writers and formed a fruitful topic for speculative discussion. But many years elapsed before systematic investigation began to be made into the *modus operandi* of earthquake forces, for it is only within a short time that "seismology," or the science of earthquakes, can be said to have acquired a right to an independent name and existence among the numerous branches of scientific inquiry.

It being admitted by all that an earthquake shock is caused by an impulse communicated to the earth, at some point beneath the surface, the first questions which would naturally suggest themselves would be: Where is that point situated, and what is the cause or origin of the impulse? These might seem very easy questions to ask; but it is only within a very few years that either of them could be answered with any precision of statement. The line of seismological inquiry followed for a long time an easier and more obvious route. The first step was to compile and collect from every possible source historic accounts of all the earthquakes which have ever happened, and of which any records have been preserved. This would furnish a body of material capable of being used in various ways, and which could not fail to give valuable hints as to future desirable points to be investigated.

Several authors have been engaged in compiling earthquake catalogues; but Mr. R. Mallet and M. Alexis Perry have made by far the most important contributions to this department of knowledge. Mr. Mallet published a catalogue of all the recorded earthquakes from 1606 B. C. to 1842 A. D.—a work of immense labor, in which he had the assistance of the British Association for the Advancement of Science, and in whose proceedings it was published. This catalogue has been extended by Perry, Kluge, and others, and has formed the basis of numerous more or less valuable speculations and combinations.

One of the first questions which would suggest itself in working up this material would be: In what regions is the crust of the earth most unstable? To present to the eye an answer to this question, seismographic maps have been prepared, showing the distribution of earthquakes over the whole surface of the globe, their relative frequency and intensity being shown by varying tints of color. From such maps important hints have been gathered; and it would be very difficult for any one who has studied them to arrive at any other conclusion than that earthquakes are phenomena connected with, and closely related in their origin to, volcanoes, mountain chains, and coast lines; in short, one could hardly, by any possibility, fail to perceive that vibrations of the earth's surface are phenomena having a deep geological significance, and not mere local and superficial occurrences, without any inner connection with each other and the past history of our globe. It is clearly shown by these maps that great earthquakes are con-

nected in their place of occurrence with the position of the oceanic basins and with the existence of great mountain chains; also, that they are much more liable to occur where the more recent geological formations exist, and especially where these bear the marks of geological disturbance, or are turned up at a high angle, indicative of change of position since their deposition.

Another line of inquiry is suggested by the comparison of earthquake catalogues and the examination of seismographic maps, the results of which point in the direction just indicated. This is the connection of earthquakes with volcanoes, whether active, dormant, or extinct. The almost invariable occurrence of seismic disturbances at the time of volcanic eruptions, the remarkable coincidence of areas most liable to heavy shocks, with those of the greatest volcanic activity, the often noticed fact of the cessation of earthquake disturbances at the moment of the commencement of activity in some neighboring volcanic vent—these are facts which cannot be overlooked, and the popular idea of the casual connection between volcanoes and earthquakes is clearly founded in fact, as every geologist is willing to admit. This connection was distinctly recognized by Humboldt, many years ago, and fully set forth in the pages of "Cosmos," and by him the term "volcanism" was used to include all the phenomena of earthquakes, volcanoes, solfataras, hot springs, and the like.

We consider it as clearly proved that earthquakes are geological phenomena, and that their causes and effects are to be studied from that point of view, as has been done, indeed, more or less thoroughly and completely, ever since geology began to assume a position as a science. Early geology, indeed, was hardly anything more than vague speculation as to the cause and nature of volcanic and seismic phenomena, as a reference to the works of the older authors—from Strabo down—will clearly show.

The aim of modern science is to give more precision to the results of all investigations, and the study of earthquakes has begun to make steps forward in this direction, although the path in this line of inquiry is one beset with difficulties.

It is much that already, even if only for one or two great earthquakes, we are able to state with precision the depth and position of the point at which the shock originated, and that the methods have been worked out by which similar results can be obtained with facility in other great earthquakes, provided the conditions of their occurrence are favorable.

It is chiefly to Mr. Mallet that is due the credit of having inaugurated a more scientific method of investigation into seismic phenomena than was formerly in use, and his great work on the Neapolitan earthquake of 1857 is an admirable example of what can be effected in this direction under favorable conditions for the collection of facts, and with time and means at one's command for entering into an exhaustive discussion of them. It will rarely happen, however, that circumstances will be found so admirably adapted for giving good results as they were in the great earthquake investigated by Mr. Mallet. The region in which it occurred was densely populated and thickly covered with buildings, many of which were very large and substantial, such as old convents and cathedrals, and of a kind well calculated to preserve a record of the passage of the waves of motion through them. The only other elaborate investigation of the same kind yet undertaken, so far as we know, is that of Mr. Oldham, the chief of the India Geological Survey, into an earthquake which happened in Cachar in 1869, but the results of this inquiry have not yet reached us.

With the above brief statement of the nature of earthquake phenomena, we may proceed to inquire what general results can be gathered from the

facts observed in connection with the seismic disturbances in Owens Valley. And, in this connection, we shall be led naturally to a consideration of the nature and origin of the forces by which the wave is set in motion, which, as it emerges to the surface, produces such disastrous effects as those described in the preceding paper, or the still more fearful ones which are so familiar to us in the accounts of the great Lisbon earthquake, and of other calamities of this kind, in which populous cities have been instantly destroyed and thousands of their inhabitants killed.

And we may first notice the extent of the area over which the disturbances of March twenty-sixth and the following days were felt. The shock does not seem, from any facts which can be gathered, to have been perceived in the extreme northern portion of the State; but it was quite severe in the direction of the axis of the Sierra Nevada, as far south as Camp Cady, in the Mojave Valley, while beyond that, in the same direction, the country is an uninhabited region, from which no accounts are likely ever to be received. It is safe to say that at least two thirds of the area of the State of California was shaken by this earthquake, or fully one hundred thousand square miles. How much of the adjacent State of Nevada was disturbed by the same shock we shall probably never know with any considerable approach to accuracy, the region being one so sparsely populated. It is probable that nearly the whole State was affected, and certain that at least fifty thousand square miles of its area was, thus making, in California and Nevada, an area of over one hundred and fifty thousand square miles set in motion by one impulse. The farthest points from which information has come of the shock of the twenty-sixth of March having been felt are about one hundred and fifty miles distant in a direct line from the axis of the Sierra, on each side, and this belt of three hundred miles in width was fully five hundred miles in length, in a northwesterly and southeasterly direction.

It is a matter of congratulation that the central area of the disturbance lies in one of the most thinly settled portions of the country. East of Owens Valley, with the exception of two or three small mining camps at the east base of the Inyo Range, there is no white population at all, until we reach the borders of Utah—a region probably outside of the area of disturbance. The region just east of the Inyo and White Mountain Range is dry, barren, and desolate in the highest degree, and remains mostly unexplored to this day. West of Owens Valley is the highest Sierra, as it may be called—a stupendous pile of mountains—not only uninhabited, but hardly accessible, except to the skillful mountaineer, during two or three months of those years when the snow is ordinarily deep. A belt two hundred miles long and one hundred broad, probably includes the area where the shock was so violent as to be classed as destructive, and within this area not more than one thousand to one thousand five hundred persons were living, and these almost exclusively in Owens Valley.

The same conditions which seem so desirable from the point of view of the humanitarians—since they indicate clearly, that, if a great shock must come, it could not easily be placed in a region where it would do less damage to life and property—present themselves in a very different light to one seeking scientific information in regard to its occurrence. Our data are necessarily very vague on many points; and just the region from which we most desire information is uninhabited, and this year, perhaps, quite inaccessible, for the high mountains to the west of Owens Valley have never been so deeply covered with snow as they were during the preceding winter.

We know that the shock of the twenty-sixth of March was severely felt in Salinas Valley, at the eastern base of the Inyo Range, and from beyond

that we have no information until we reach the White Pine Mining District, a distance of fully three hundred miles. With regard to the extension of the area over which this shock was felt in the direction of Arizona and Mexico, our data are also extremely vague. The farthest point in California, in the direction of the axis of the Sierra, from which we have any account whatever, is Camp Cady, on the Mojave road. Here a Government wagon train happened to be passing or staying at the time of the shock, which the conductor of the train represents as having been very severe—so much so as to throw the mules off their feet. A quite independent report came to San Diego of the occurrence of a tidal wave on the coast of the Gulf of California on the morning of March twenty-sixth, showing that the shock was certainly felt as far as this in that direction. It is also true that the City of Mexico was shaken on the same day, between eight and nine in the morning, which would correspond nearly in time with the half-past six o'clock shock felt so severely in California on that day. But the data are too incomplete as yet to enable us to say, with certainty, that the disturbances which occurred in California and Mexico on the twenty-sixth were continuous over the whole intermediate distance, so that they can properly be considered as belonging to one earthquake, or whether they were different shocks starting from distinct centers, and not due to one impulse. The latter is the most probable hypothesis.

It seems very clear that there are times when the earth's crust is in a peculiarly "ticklish" condition—if the expression may be allowed—so that one portion is ready to respond to another by a nearly synchronous movement. Thus it happens, that, for weeks or even months in succession, we are constantly hearing of disturbances of the equilibrium in every quarter of the globe. Such a time as this was the autumn and winter of 1755—the year of the great Lisbon earthquake—when, for several months, with occasional intervals, the whole circumference of the Atlantic Ocean was in a disturbed condition, while the East India Islands, on the other side of the globe, were the theater of violent seismic demonstrations. Still more remarkable was the earthquake cycle of November, 1852, when the Pacific Coast of North and South America vibrated synchronously, on the grandest scale, with the whole of the East Indian Archipelago. At this time both borders of the Pacific Ocean, from China to Australia on one side, and from California to Chili on the other, were in a condition of seismic disturbance, while minor disturbances were taking place in the intermediate regions. This earthquake period lasted nearly two months.

A similar, and perhaps even grander, display of seismic forces appears to have been exhibited during the past winter and spring; for the statements which have come in from every quarter of the globe show clearly enough that the number of severe and even destructive earthquakes which took place about the time of the Owens Valley shock was, indeed, most extraordinary, while the attendant phenomena of volcanic action have been equally remarkable.

The following extremely concise list of earthquake and volcanic disturbances, which occurred during the spring of 1872, is presented as evidence of the above statement; and it must be remembered that this catalogue is necessarily imperfect, both on account of the slowness with which such information comes in, and our distance from the most direct and authentic sources of information. The time embraced is from December to April, 1871–72:

December 23–January 6.—Terrible earthquakes in Persia. Khabooshan, in northwest Khorassen, entirely destroyed, and thirty thousand persons killed.

January.—Severe earthquakes in Australia. Regions afflicted by them which never before had been shaken since the country was settled.

January 16.—Shamaka, at the southern base of Caucasus, seventy-five miles west of the Caspian Sea, entirely destroyed, and over one hundred persons killed. The surrounding country suffered severely.

January 28.—Smart shock in Malaga, at 3:01 P. M., lasting from four to six seconds.

February 6.—At Winona, Minnesota, 8 A. M.

February 8.—At Cairo, Illinois, 5 A. M.

March 6.—In central and eastern Germany, a large area shaken; disturbance lasted over an hour.

March 11.—Yokohama, Japan. About this time destructive earthquakes took place in Japan. The town of Hamada was destroyed, and five hundred persons killed. The "North China Herald" says, in its Japanese news: "Great earthquakes in the south, and much damage to life and property."

March 23.—At Unionville and Winnemucca, Nevada, slight shocks.

March 26.—The series of earthquakes in California and Nevada commenced, and continued for two months and over; especially severe at the eastern base of the Sierra Nevada, in Owens Valley, where between twenty and thirty persons were killed. This earthquake was felt over all of California, except its extreme northern end, and throughout nearly all of Nevada.

March 26.—The same day as the Owens Valley earthquake, the City of Mexico was shaken, between 8 and 9 A. M. It is said that this disturbance extended over a wide region to the south; that Oaxaca was seriously injured, and that the volcano of Colima burst into eruption. No authentic details, however, of these occurrences have been received.

March 26.—Slight shock at Paducah, Kentucky.

March 28.—Slight shock at Salt Lake City.

April 3.—Terrible earthquake at Antioch and vicinity; felt far to the east, and over a wide area of territory. The shocks continued for a week or more. Some one thousand or one thousand five hundred persons were killed in the vicinity of Antioch.

April 14.—Earthquake at Accra, on the Gold Coast of Africa.

April 15.—The volcano of Merapi, in Java, which had been quiet since 1863, burst into a terrible eruption. Great destruction of life and property followed.

April 16, 17, and 18.—Severe shocks in Iceland, partly estroying the town of Hasvick.

April 24.—Mount Vesuvius commenced its greatest eruption since 1632, much loss of life and property resulting.

April.—Eruption of Mayou, a magnificent volcano in the Philippine Islands. A letter published in "Nature," May 16, 1872, from W. W. Wood, of Manila, says: "The terrestrial disturbances still continue in the Philippine Islands, and almost every post brings us intelligence of earthquakes in the provinces. The past year has been remarkable for the great number of earthquakes throughout the archipelago, especially on the great island of Mindanao, where the new military colony suffered severely."

From the above list—which no doubt will be extended considerably, as detailed news reaches us from the far off regions of the earth—it will be seen that the winter and spring of 1871–2 were a season of extraordinary seismic disturbance; North America, Iceland, Europe, Africa, Asia, the Japanese, the Philippine, and the East India Islands, as well as Australia, being all visited by severe shocks, which in many cases were highly destruct-

ive. Probably over fifty thousand, and possibly as many as one hundred thousand, lost their lives in these convulsions of nature. This excited period lasted over four months.

It may now be asked: What general results can be drawn from the Owens Valley earthquake, and can any light be thrown on the special causes of that disturbance?

In the first place, the impulse by which this earthquake was originated was undoubtedly given somewhere nearly in the axis of the Sierra Nevada, and the resulting waves were propagated in both directions away from that axis and nearly parallel with it.

The impulse originated—or, as we may say, the blow was struck—at the same moment along a line of very great extent, probably as much as a hundred miles, perhaps considerably more. This is indicated by several considerations, and especially by the times at which the shock was felt at various points in California and Nevada.

In preparing a statement of the times at which the wave of the first great shock reached the surface at different places we have encountered great difficulties, as it was easy to foresee. There is no absolutely accurate record of the instant when the shock occurred at any locality, because there are no self-registering instruments (seismometers) anywhere on the coast or in the interior. The nearest approach to accuracy is the observation of Mr. Thomas Tennent, of San Francisco, who is an experienced observer and has the means of determining the local time with precision. Some of the statements published in the newspapers are quite wild, and evidently far from the truth. Indeed, the local time is rarely known at any point off the line of the telegraph with anything more than a distant approach to accuracy; and besides this difficulty we have, of course, the uncertainty which always attends the observation of the precise instant of the occurrence of a catastrophe of this kind by any other than self-recording machinery, which acts independently of the alarm and agitation by which an earthquake shock is naturally attended. The mental faculties are not to be trusted when the earth is in motion under one's feet.

However, by a careful comparison of between fifty and sixty statements of time, at as many different localities, chiefly obtained from telegraphic reports in the newspapers, it seems quite clearly established that the great shock of half-past two on the morning of the twenty-sixth of March was felt simultaneously at points situated along lines drawn parallel, or nearly so, to the axis of the Sierra, and extending longitudinally through that portion of the State comprised between the parallels of 34 and 38 degrees, or from the latitude of Los Angeles to that of San Francisco. The same appears to be true for the region on the eastern side of the Sierra, although here the data are very meager. Our defective observations allow us to make no more precise statement than this: that the seismic wave reached the center of the San Joaquin Valley in from two to three minutes; the center of the Sacramento Valley in from three to four minutes; and the coast, from San Francisco to Los Angeles, in from four to five minutes, after it had started, or after the impulse had been given along the line of the axis of the Sierra. If the time given for the occurrence of the shock at White Pine, Nevada, can be trusted, the disturbance was felt there at very nearly the same instant that it was at San Francisco and Los Angeles. This much can be safely stated: that the shock was very nearly synchronous at points situated on lines parallel with the axis of the Sierra, and through a region extending between two and three hundred miles in a northwesterly and southeasterly direction.

While no great accuracy is to be expected in results obtained from the data at our command, when examined with reference to a determination of the velocity of transit of the wave, it is nevertheless true that the figures are less discordant than might have been expected. From thirty to thirty-five miles in a minute seems to have been the rate at which the disturbance passed from point to point, on the surface, if measured in a line at right angles to the axis of the Sierra. As far as our imperfect data enable us to judge, the velocity of transit was nearly the same in both directions from the axis. In other words, the shock was felt simultaneously at points equidistant from the crest of the Sierra on both sides of the chain.

As before remarked, the fact that the whole of the higher portion of the Sierra, from Silver Mountain south, is entirely uninhabited, and even unvisited, except in summer, is sufficient reason why we have no data from the higher portion of that claim with reference to the severity of the shock. No doubt that it was very heavy, and especially in the high Sierra at the head of Kern and Kings Rivers. Indeed, the reports of the terrific noises of falling rocks heard in the direction of the crest of the range by settlers in the foothills east of Visalia, appear to be well authenticated, and indicate great disturbances of the surface in that region. The shock was felt severely in the Yosemite Valley, at an elevation of four thousand feet above the sea, and large quantities of rock are said to have been thrown from the cliffs by which it is surrounded. Farther north, where settlements extend to the summit of the Sierra, as at Silver Mountain, the Placerville Pass, and on the line of the Central Pacific Railroad, the shock seems to have been felt less severely than it was lower down on the flanks of the range. Indeed, there are several reasons for believing that the axis of the shock was not exactly coincident with the axis of the Sierra, but slightly oblique to it, inclining to the west as it is traced north, and also leaving the Sierra to the south and passing off eastward.

That the wave of the shock emerged from under the Sierra, in the region between Owens Lake and Bishop Creek, in a line nearly parallel with the axis of the chain, is sufficiently established by a consideration of the position of the fissures in the soil and rocks, and of the direction in which objects were thrown by it. As the wave entered the valley, its advancing edge was probably somewhat convex to the east, and a portion of it was deflected from its normal course and forced to expand itself toward the north and the south, perhaps undergoing several reflections from one wall of the valley across to the other, and thus complicating the disturbance, and adding seriously to the destructive character of the shock.

Of the depth at which the impulse started by which this disturbance was produced, we have no precise statement to offer. The want of self-registering instruments, the perishable and crumbling character of the buildings overthrown or partially demolished, the limited area occupied by them, these are the circumstances which entirely prevent any accurate deductions being made in regard to the distance from the surface of the seismic focus. There can be no hesitation, however, in saying that this depth was very great—probably not less than fifty miles. This we infer from a variety of circumstances connected with the effects of the shock, such as the position of the cracks in various buildings examined, indicating the emergence of the wave at a very steep angle on both sides of the Sierra; the great extent of the areas affected by the shock; the synchronous occurrence of the disturbance at points so very distant from each other, and the very great velocity with which the wave progressed on the surface, which could only have happened from the giving of the impulse at great depth.

No shallow wave could have affected so extensive a region almost synchronously. Indeed, it is safe to affirm, that, wherever very wide areas of territory are shaken, the cause must be a deep-seated one. The wave must die out within a limited area, if propagated only from the surface, or from a point but little beneath it. In this light we may compare, in respect to the destructive effect produced, the deep-seated earthquake and the superficial explosion like that of the nitro-glycerine factory near San Francisco, to which reference has already been made. The nearer the surface, the more violent the effects of the explosion, but over a proportionally lessened area. A ton of nitro-glycerine, exploded at a depth of twenty-five or fifty feet beneath the surface, would probably tear everything to pieces, and destroy all living things, within a radius of a few hundred feet; if buried a thousand feet deep and then exploded, the destructive effect on the surface would probably be almost null, although the ground would almost certainly be perceptibly shaken for many miles in all directions.

Considerations like these indicate how stupendous the force must be, which, starting from such great depths beneath the surface, yet produces a destructive effect over so wide an area, and perceptibly moves a mass of material, the superficial extent of which is to be measured by hundreds of thousands of square miles. And it must be remembered that it is not the surface only which moves but the whole mass of the earth underlying the disturbed area, down to the seismic focus itself. It would be useless to compute the number of cubic yards of material moved by one of these great convulsions of Nature, for the figures would be almost too great for comprehension.

The nature of the force which originates the impulse, the results of which are manifested in the form of the earthquake, remains to be considered. What this is has already been indicated when showing that the phenomena of earthquakes are intimately connected with those of volcanoes, mountain building, and continental upheaval. Earthquakes, then, are simply jars in the crust of the earth occasioned while this is undergoing those changes of level of which we see the results in the mountain chains which encircle the globe, and the continental areas and oceanic depressions by which its surface is diversified. There are abundant reasons for believing, and most geologists do therefore believe, that the earth was once a mass of molten matter, and that it has been for unnumbered ages cooling down to its present condition. They infer that the inequalities of its surface have come into existence during the progress of this cooling, and chiefly as the result of the effort of the consolidated crust to adapt itself to the still shrinking nucleus; in the course of which operation this crust has been broken in various places, portions of it pushed up on one side or the other of the fissure, other portions bent, or even folded together, and, in short, all the varied forms of mountain chains developed as we now see them. Neither must it be forgotten, in this connection, that it has often happened that the molten material of the interior has found its way to the surface through these fissures, thus giving rise to the complicated phenomena of volcanic outbreaks and lava flows, and of mountain chains with axes of eruptive and crystalline rock. It is certain that the mountain masses like the Himalaya or the Andes have not been lifted five miles vertically above the sea level without prodigious exertions of force; and there are abundant reasons for believing that this force has acted in such a manner as to make itself sensible in the earthquake, as one of its manifestations.

On the usually adopted theory of mountain building the crust must be in places in a condition of tension, and in others of compression. Tension or compression accumulates, until the cohesion of the material is no longer

capable of resisting the pressure, and the rocks give away, a fissure is suddenly formed, and a powerful impulse communicated to the superincumbent mass. A wave of motion is thus started, spreading in all directions, and becoming manifest when it reaches the surface. Just as when a number of balls of ivory, or more elastic material, are suspended in juxtaposition with each other, and one is drawn back and then let go, so as to strike on the next to it, which receives the impulse and transmits it to the next without itself perceptibly moving, and so on, until the last or outside one of the row is reached, which then flies off—thus proving that the motion has been transmitted from one ball to the next—so the wave of motion is transmitted through the crust, which shows no change after the transmission, provided the material be homogeneous, all of the effects being displayed upon the surface, when the wave passes out into the atmosphere. Thus we see how it is that earthquakes are so little felt in mines, especially in deep ones; and also, why the effects of the shocks are chiefly perceptible on the surface where there is a break in the geological formations, as in Owens Valley, where the sagebrush slope joined the alluvial soil, the dry abutting against the wet material. At such points the rate of motion of the wave is changed in consequence of the change in the density and elasticity of the material through which it is passing, and here a disturbance necessarily ensues.

There is reason to believe that the portion of the Sierra which lies in the vicinity of Owens Valley is in a rather unstable condition of equilibrium, such as the geological conditions of the region as has already been suggested would lead us to expect. This stupendous mass of rocks, deeply intersected by cañons with almost vertical walls, and situated between two ranges of different geological ages, would seem to be an excellent field for geological disturbances, and especially for such as might have their origin in the compression exercised by an enormous weight of material raised to a vertical height of two or three miles above the surrounding country. We were informed, on entirely reliable authority, that the region at the head of Kern River, deep in the recesses of the Sierra, and near the line where the Hackett trail from Visalia to Owens Lake crosses that stream, is the scene of almost incessant earthquake shocks, which are accompanied by loud explosive sounds, and frequently by the noise and crash of falling rocks. These disturbances have been repeatedly felt by parties going up from Owens Valley to hunt and fish in that region, and in some cases they have been so alarming as to cause the visitors to take rapid flight from the disturbed district. Similar stories are told about the country at the head of Kaweah River, but of these we have no positive authentication. For how long a time these shocks and noises have been felt in the high Sierras, we have no means of ascertaining. Certainly they have been experienced there for three or four years. It is worthy of notice, in this connection, that there are several well formed cones in this part of the range, indicating, by their appearance, a quite recent cessation of volcanic activity.

A few words may be added in reference to the sounds heard in connection with the vibrations of the surface during and after the great shock of March twenty-sixth. At the time of the occurrence of the first throe, by which all damage was effected, and which was far heavier than the succeeding ones, noises were heard, which are described as having been terrific, resembling repeated discharges of heavy artillery, accompanied by a rolling fire of musketry. These sounds continued for some time; but whether they lasted longer than the heaviest vibrations did, we were unable to ascertain. That they were caused by the actual tearing asunder of the rocks, there is little reason to doubt; and they were heard in a succession of crashing

reports, continued for a considerable time, because the fissures produced were along a line of great extent, the extremities of which were many miles distant from any one point in the valley.

Hence, the sound necessarily reached the ear at different intervals of time, according to the distance which it had to traverse. The explosive reports, heard by our party just before noticing the light vibrations of the surface, which were felt while we were in Owens Valley, were not actual explosions, such as would be produced by the ignition of detonating gases; for there is nothing in the character of the rocks of that region to warrant any such supposition as that there was anywhere a disengagement of explosive substances from them. The mass of the mountains is of granite, which cannot by any possibility be made to give off anything of an explosive nature. The volcanic rocks of this region are equally inert in themselves, and no signs of active volcanism in the region were discovered. All these sounds seem to be due to one and the same cause; namely, the cracking and rending of the rocks in their prolonged efforts to get themselves into a position of equilibrium. They were produced near the surface, and hence were heard and felt over only a comparatively small area.

They were heard as coming from the direction of the Sierra, in all cases, and evidently by sound waves borne through the atmosphere and not through the earth. The detrital mass which fills the bottom of the valley and extends high up on the flanks of the Sierra, is made up of loose fragments of rock, of all sizes, mixed with gravel and sand, and would seem to be a material eminently ill-fitted for the propagation of the waves of sound. These must have emerged into the atmosphere, high up in the mountains, where the rock is bare of detritus, and have thence been borne to the ear through the air.

Having thus given some of the general scientific conclusions which we have felt justified in drawing from our observations in Owens Valley, we will append a few words of practical application—a branch of the subject to which we expect to be able to revert at some future time.

That there ever can be any hope of our being able to predict the time of occurrence of an earthquake shock, is in the highest degree improbable. Seismic disturbances do not belong to a class of phenomena of which we can ever expect to know much in detail. We can say that such and such regions are more liable to be visited by these catastrophes than others are; but when they will happen, there is no possibility of ascertaining in advance. Neither are the various warnings supposed to be given by peculiar meteorological occurrences of any value. There is a slight preponderance in the number of shocks occurring in winter over that of the summer disturbances, and it is quite probable that the moon is not without some influence on the movements of the crust of our planet. But neither of these circumstances affords any basis for prediction.

If the evils of earthquakes can in any way be mitigated, it is in preparing for them by building in a suitable manner. It was the opinion of Mr. Mallet, formed with much deliberation, after his elaborate investigation of the Neapolitan earthquake, that most of the horrors of these catastrophes might be averted by proper care in the construction of houses and public buildings. This opinion is of great value, because this able investigator had the most excellent opportunities of studying the effects of movements of the crust on edifices of a great variety of form and material.

The results of the Owens Valley earthquake are not without considerable value in this respect. The fact that wooden buildings are superior to all others for regions liable to severe shocks seems clearly established, at least in cases where the edifice is to be one of moderate cost and size. We would

not be taken as positively asserting that a building of brick or stone may not be made as safe as one of wood, but it is clear that it can not be without a very much larger expenditure of money. Of all the materials which can be used for building purposes, the adobe is the most unsafe. The walls built of this material have the least possible cohesion and elasticity. However convenient the adobe may be in certain localities where wood is dear and protection from cold wind and hot sun much to be desired, it should not be used anywhere on this coast. Where brick buildings are absolutely necessary, as in large cities, they should be constructed in the most substantial manner, with special regard to the quality of mortar, and well tied together with iron rods. The use of heavy cornices and massive chimneys should be entirely abandoned. In all the brick buildings overthrown or badly injured by the shock of March twenty-sixth, the bad quality of the mortar was most distinctly noticeable.

That of the Court House at Independence, which was almost destroyed by the earthquake, had no more coherence than so much dried mud.

Finally, the desirability of a scientific record and examination of the earthquakes occurring on this coast is too great not to be here touched upon. Three observatories, at least, should be established and fitted up with self-registering instruments, like those of Professor Palimeri, on the flanks of Vesuvius. The cost would be nothing like as great as that of establishing and supporting one efficient astronomical observatory.

KERN COUNTY.

By W. A. GOODYEAR, Assistant in the Field.

This county is bounded on the north by Tulare, on the east by San Bernardino, on the south by Los Angeles and Ventura Counties, and on the southwest and west by San Luis Obispo County.

Into the report concerning Kern County have been woven some notes of travels for the old Geological Survey in 1870.

The name printed "Tehachapi" in the recent railroad time tables and gazetteers, has probably been spelled in as many different ways as any other word of Indian origin ever was. It is said to mean the "Valley of the Oaks." In the United States Pacific Railroad Report, Executive Document, No. 78, Senate, Thirty-third Congress, Second Session, published in 1856, on page 18, it is spelled "Tah-ee-Chay-Pah." In the "Geology of California," Volume I, published in 1865, on page 217, *et seq.*, it is spelled "Tahichipi," and it is there stated that, to avoid confusion, the spelling of the United States Surveyor-General's office was followed. It has since then been spelled in many different ways, such as "Tehachipi," "Tehachipa," "Tehichipi," "Tehichipa," "Tahachipa," and many other ways. But, if the testimony of Mr. P. D. Green, who has lived there nearly thirty years, can be accepted as to the Indian *pronunciation* of the word, it is a word which cannot be written in English without some explanation, for it involves a sound which the English language does not contain, and which is almost identical with the German "*eu.*" As Mr. Green repeated the Indian pronunciation to me, the best way in which I can spell it is: "*Tehêuchipa*," the vowel *e*, in the first syllable, sounding very indistinct, the German diphthong "*êu*" being *very strongly accented*, and the vowels *i* and *a*, in the last two unaccented syllables, sounding very indistinct. The *h* following the first syllable is very strongly aspirated, and the *ch* after

the German diphthong "êu," has the same sound as in the English word "church." I shall use this orthography hereafter.

The locality of marble referred to in the sixth annual report of the State Mineralogist, Part I, page 23, was visited June 18, 1888, and was found to be on the south side of Brights Valley, about seven miles in a direction south 55 degrees west, magnetic, from Tehêuchipa railroad station. This marble is mostly white, but often with a slight bluish tinge, and sometimes mottled, as stated in the report referred to. It is most of it moderately fine grained. It strikes about northwest, and dips some 50 degrees to the northeast. It contains here and there small quantities of micaceous iron, and also some very poorly preserved, indistinct remnants of what were probably once *crinoidea*. It is also traversed by irregular seams or veins of granitoid rock, which contain some tourmaline. Some of it is highly siliceous. A considerable quantity of it has been shipped from here in the past, and it forms a part of the foot pavement in front of the main McAllister-street entrance of the New City Hall in San Francisco.

Brights Valley is about one and one half miles in diameter. Half a mile southwest of it, over the hill, comes Cummings Valley, which is probably ten miles long by four miles wide. About fifteen miles from here, and about west from the north end of Cummings Valley, lies Bear Valley, some two miles wide and four miles long. All these valleys lie to the northeast of the Téjon Cañon and Creek, and the first two of them drain into it. Téjon Creek heads in the country to the south of here, and around on the southern flanks of the Tehêuchipa Mountain, whose highest crest bears south 60 degrees east, magnetic, from here, and is something over eight thousand feet above the sea, instead of seven thousand, as previously estimated in the "Pacific Railroad Reports," Volume V, and in the "Geology of California," Volume I.

At the mouth of Grizzly Cañon, about three miles in an air line, a little west of south from Tehêuchipa Station, are the limestone quarry and kilns of J. J. Hendrickson. The limestone here is crystalline, some of it fine grained, and some of it very coarse grained. Some of the latter has a very handsome pale-blue color. It contains some graphite, and varies much in quality. Some very white rock is full of acicular prismatic crystals, is hard and tough, and highly siliceous, and will not make good lime. Just above here begins a somewhat extensive area of placer mining, a good deal of ground having been hydraulicked off here in the winters of years gone by, though nothing is being done here now. A little further up the cañon are the two lime kilns of Henry Seeger; his quarry is about one thousand five hundred feet east of the kilns, and the rock is of essentially the same character as that of Hendrickson. The limestone is accompanied by some slate, highly metamorphosed, the whole striking northwesterly and dipping northeasterly.

The aneroid barometer at Hendrickson's read four thousand six hundred feet. The country in the neighborhood is chiefly syenitic granite. Above Seeger's is a "Huntington" quartz mill, owned chiefly by R. B. Hayes and Geo. C. Perkins, with a capacity of from five to seven tons per twenty-four hours. Still further up the cañon is an eight-stamp quartz mill, owned by F. A. Tracy. Both of these mills were idle at the time of our visit. At the Tracy mill the aneroid barometer read five thousand three hundred feet. At J. Tungste's place, it read five thousand six hundred feet, and at the outcrop of the Pine Tree Mine, in the upper part of Grizzly Cañon, it read six thousand one hundred feet.

The Pine Tree Mine is said to be a well defined vein of quartz, striking about east and west, magnetic, through the granite, and dipping south about 25 degrees. It has been worked to a depth of two hundred and eighty feet, and a length of some three hundred feet along the vein. The vein ranged from eight to nine feet in width. It carried large quantities of blue and white clay, and most of the ore came out of the mine in a broken and crushed condition. It yielded from $8 to $30 per ton, the general range being from $14 to $17, the bullion being worth from $14 to $15 per ounce. There are about nine thousand feet of "claims" on this vein, and a number of shafts have been sunk and tunnels driven.

At a point in Pine Grove Cañon, which runs northwesterly out of the mountains, and where the aneroid barometer read five thousand seven hundred feet, Godfrey Poirier has a limestone quarry, and on June 18, 1888, was building a large kiln. The limestone here is of the same general character as that of other quarries above noticed. Pine Grove Cañon is a branch of Antelope Cañon, which heads in the main Tehêuchipa Mountain, and runs northerly out of the mountains to the Tehêuchipa Valley.

At the mouth of Pine Grove Cañon is Thurber's place, and the five-stamp mill of the Homestake Company, which is now idle. The aneroid barometer here read five thousand four hudred feet.

A little ways below here, in Antelope Cañon, are the two upper kilns of the Summit Lime Company, where the aneroid read five thousand and sixty feet. A little further down the cañon the same company has two other kilns, which, on June eighteenth, were burning, and unfinished. At the same time they had just drawn the contents of one of the upper kilns, which held about seven hundred barrels of lime. I was told that it took seventy cords of wood to burn this kiln, and that the general average here is one cord of wood to ten or twelve barrels of lime.

Still further down Antelope Cañon Mr. Anderson was building another large kiln.

In Antelope Cañon, one fourth mile above the Homestake Mill, there is said to be another lime kiln, which is one of the continuously working sort.

About three miles southeast of the railroad station, and about seven hundred feet above it, in the northern foothills of the Tehêuchipa Mountains, is the old "Two to One" Gravel Mine. The heavy body of gravel here is evidently a deposit formed by an ancient stream, which at one time flowed in a northeasterly direction out of these mountains into the valley. The bowlders here are mostly granite. But there is some limestone, and here and there a few dark-colored fragments of volcanic rocks; and one bowlder was found very smoothly rounded, and four or five pounds in weight, of pure magnetic iron. There is said to be a heavy volcanic dike in the granite, about half way up the northern slope of the mountain. Considerable surface washing and some drifting has been done here in the gravel, and the diggings are said to have paid an average of $6 to $8 in gold per day, per man. A so called "dry washer" was largely used here.

About one and one half miles east of Tehêuchipa Station the foothills on the north side of the valley consist of limestone, of which the quantity here is very great, and another new lime kiln was also (June nineteenth) in process of construction.

The great mass of the country yet seen is granite, however, in spite of the heavy bodies of limestone and the irregular spots and belts of other metamorphic rocks which occur in it here and there.

About eight miles east of town is the mouth of the Charley Moore Cañon, which comes into the valley from the north, and all the country east of

this cañon, so far as seen, is of volcanic origin, most of it being stratified beds of volcanic sand. Two miles east of this cañon is Sand Cañon, which runs south to the head of Cameron Cañon, at the extreme east end of the valley. Cameron Cañon is the one referred to in the "Geology of California," Vol. I, page 217, as then being without a name, and as being the principal drainage stream of the valley, which it is, and it flows southeasterly through the mountains to the Mojave Desert.

It is among the lower hills, on the east side of Sand Cañon, some two or three miles above its mouth, that the "green sandstone" is found which has been quarried to some extent for building purposes. It is a handsome stone. The sand of which it is composed appears to be almost entirely of volcanic origin, though it contains occasional pebbles of granite and other rocks. Some of the adjacent beds are exceedingly fine grained, and contain impressions of fossil leaves, of which, however, good specimens could not be procured.

At the first locality visited, the quarry has been worked to a considerable extent, and a large quantity of stone shipped by a Los Angeles company. The desirable stone occurs in beds from one to three or four feet thick, lying nearly horizontal. It contains, in places, considerable mica. Another locality where there is some good stone of similar character, is about one mile further up the cañon; but very little work, however, has been done there. The stone is generally rather soft.

The area covered by the "salt lake" at the eastern end of Teheûchipa Valley, on the twentieth of June, 1888, was about one square mile. It was very shallow, its maximum depth probably not exceeding five or six feet. At the same time its water was nearly a saturated solution of common salt, and it was quite muddy from fine clay held in suspension and stirred up from the muddy bottom by the high winds which sweep over the lake. At times, in the winter, the water stands four or five feet higher; but in the late summer and fall, it nearly disappears, by evaporation, and leaves its bed covered with a white incrustation of nearly pure salt, which sometimes reaches a thickness of four inches or more. It is said that from two hundred to three hundred tons of salt are gathered here every year. The crust is simply raked up into little heaps of one hundred pounds or so each, which are then shoveled into a sort of scow, holding eight hundred to one thousand two hundred pounds each, in which it is hauled out from the soft muddy bottom, on to harder and drier ground. It is not recrystallized at all, and receives no further treatment than that just described. The salt is generally very pure, and two analyses made of it some time since are stated by Mr. P. D. Green to have shown respectively, one of them between 92 and 93 per cent, and the other one 98 per cent, of chloride of sodium.

A little over one mile distant, in a direction about north 70 degrees west, magnetic, from the town of Tehêuchipa, there is a large outcrop of basaltic rock, one thousand or one thousand two hundred feet long in a north and south direction, and five hundred or six hundred feet wide. It appears to be a completely isolated patch; and though the rocks surrounding it are not exposed in place, yet the bowlders scattered over the surface near by it are granite and limestone. Mr. Green stated that the Indians around here had a tradition that this eruption of basalt took place within the recollections of some of their forefathers, though a great many years ago, and that there was then a great noise and great disturbance in the country; but the present appearance of the weathered surfaces of the rock indicate that the eruption has a far greater age than any Indian traditions are likely to have.

Half a mile easterly from here there are some enormous beds or veins of variegated jaspery quartz.

Half or three quarters of a mile north 40 degrees east, magnetic, from the railroad station, is an isolated knob of granitoid rocks one hundred or one hundred and fifty feet high, to the base of which a side track was laid, and from which some rock was taken for riprap work on the railroad. This rock might perhaps be called a quartz porphyry. It consists essentially of a mixture of feldspar and quartz, with little or no mica, the feldspar forming the ground mass, through which the quartz is distributed in irregular grains. It also contains imperfectly crystallized garnets. The rock is irregularly stained with oxide of iron, which greatly mars its appearance for building purposes.

From Tehêuchipa to Caliente, a distance of twenty-six miles by rail, down the mountains, most of the country, so far as can be seen from the cars, is granitic; although there are occasional belts and patches of very highly metamorphic rocks interspersed. At Keene, a station about half way down the mountains, some granite has been quarried for building purposes.

For several miles below Caliente, also, the country along the line of the railroad is chiefly granite. Then occurs a narrow belt of metamorphic rocks, which dip northwesterly towards the valley, at angles sometimes as high as 30 degrees to 50 degrees. In the lower foothills bordering the valley, these metamorphic rocks are unconformably overlaid by heavy unaltered beds of sand and gravel lying nearly horizontal.

On June 5, 1888, the writer took the stage from Caliente to Kernville. Most of the country over this road is granite; but metamorphic schists, and slates occur here and there.

Some odometer distances are as follows: Caliente Station to Rankine's, in Walker's Basin, fourteen miles; Rankine's to Havilah, eleven miles; Havilah to Kernville, sixteen miles.

Walker's Basin has on the northwest of it, and between it and the Kern River, the "Cañon Mountain" of the "Pacific Railroad Reports," Vol. V, page 15, which has now for many years, since the war of the rebellion, been called Breckenridge Mountain. And it is very evident that the high ridge on the *north* side of Kern River, where Lieutenant Williamson and party were, when they called this "Cañon Mountain" (a good enough name, by the way, and one which was probably changed to Breckenridge only by the hot feelings which raged here during the war), was the same which has since been, and is now, called the Greenhorn Mountain, it being a broad, high, and very long spur of the Southern Sierra Nevada which, immediately north of Kern River, makes out southwesterly, almost to the edge of the Tulare plain. To the southeast of Walker's Basin is the Pah Ute Mountain, another high and extensive range. Further reference will be made to these localities later on.

On June 5, 1888, the writer went directly through by the stage from Caliente to Kernville, which latter place is situated on the right bank of the North Fork of the Kern River, about three and one half miles above the junction of the north and south forks, and which he reached in the evening. And right here it is well to mention that, from a somewhat careful study of the "Pacific Railroad Reports," Vol. V, the writer is strongly inclined to believe that the stream called on page 15 of that report, *Chay-o-poo-ya-päh*, is identical with the present main *South Fork of Kern River*. At all events the accompanying topographical descriptions of the country in that report correspond as well as could be expected with that belief.

On June sixth, in company with Judge Jos. Warren Sumner, after whom the famous Sumner Mine, at Kernville, is named, the writer visited some of the Judge's present arrastras on the right bank of the main river, about

seven miles below Kernville, where the aneroid barometer read two thousand five hundred and forty feet. The country here is all granite; much of it very feldspathic, and with still more feldspathic veins or dikes running through it. Judge Sumner's present mine is about two miles southwesterly from his arrastras, and five hundred or six hundred feet higher up amongst the hills north of the river, and about one fourth of a mile southeasterly from the site of the old and now deserted town of Keyesville. It is called the Mammoth claim, and consists of several veins of quartz, striking north 20 to 30 degrees east, and dipping some 75 degrees to the southeast, in a rather uniform and moderately coarse grained granite, much of which is more or less decomposed and rather soft. The course from here to the Sumner Mine is about north, magnetic. The veins at the Mammoth claim are irregular in size and richness; the largest one is at times twelve to fifteen feet wide, but in other places it pinches out entirely.

At the locality where Judge Sumner's arrastras now are, a twenty-stamp mill was built in 1865; but this mill ran only a very short time, and has since been entirely removed, except some of the foundations and the battery blocks, which still remain. The Mammoth vein has been worked to a depth of about seventy-five feet, for a distance of some six or eight hundred feet along the vein; but only a portion of it was taken out, and large bodies of quartz are still left standing there, which are, therefore, probably poor in quality.

Keyesville was at one time quite a thriving village, with a population of several hundred people. But it appears that though a good deal of rich ore was found, there was bad management, and the veins proved somewhat unreliable, and, therefore, the town went down.

About three and one half miles above Kernville, but on the opposite or left bank of the north fork of Kern River (which here flows south), is the Charles Harley Mill, of twenty stamps, which used to run by steam, but is now idle. About one and one half miles northeasterly from this mill, and some two thousand feet above it, near the highest crest of the so called Mineral Mountain, was the Harley Mine. This mine was a vein of quartz, striking northeasterly, and dipping southeasterly in granite. The "pay streak" is said by Mr. Jas. Morris, who worked there, to have been three to four feet thick. He also tells me that a tunnel was driven northeasterly on the vein some nine hundred feet, entirely through the mountain, passing some seventy-five feet beneath its highest crest; also that the mine was worked to a depth of about one hundred and fifty feet below this tunnel, and some very rich ore taken out. He further says that the mill was built in 1877; that it ran irregularly, off and on for some five years, perhaps making three years full time. There was a rich chimney here, but it gave out, and afterwards the average ore would not pay. They had a wire tramway here, built by Hallidie, with only a single wire rope three miles long, to bring their ore to the mill.

Nearly opposite this place, on the *right* bank of the river (*i. e.*, the North Fork), is a place where there are said to have existed, a few years ago, some very strong sulphur springs, where the sulphur used to accumulate to such an extent as to sometimes catch fire and burn on the surface of the ground. But the spot is now a dry, rough, sunken area, covered with a crust which probably contains various alkaline sulphates, with some free sulphur. There are several hot springs in the mouths of the cañons, on the east side of the North Fork of Kern River, opposite and a little above Kernville, and some of these contain more or less sulphur.

The dam on the North Fork of Kern River, from which the water was taken, some years ago, for the Sumner Mill, is about one and one fourth

miles above the mill; and from this dam a belt of extremely highly metamorphosed slates extends from one half to three fourths mile further up the river, striking from north 15 degrees west to north 50 degrees west, magnetic, and dipping 75 degrees or more to the southwest. No quartz of any account was seen in these slates.

The Sumner Mill is about one mile above the town of Kernville, on the right bank of the north fork of the river. It is an eighty-stamp mill, built in 1874 and 1875, and was run by a fifty-six-inch turbine water wheel. The ore from the mine was dumped from five-ton cars into a sixty-ton bin, or bunker, whence it fell and went through a fifteen by nine jaw-crusher of peculiar lever construction, and thence dropped into small cars running on a tramway the whole length of the building. From these cars it was dumped by hand into the separate hoppers of the automatic feeders, one to each battery of five stamps. From the batteries the pulp went to Hendy concentrators, one to each battery. But later on, two of the Hendy concentrators were replaced by four Frue vanners. Below the concentrators and vanners, there are six pans and three large settlers. The whole eighty stamps are said to have been run continuously for some two years, after first starting up in the spring of 1875. After that, the mill ran spasmodically, with more or less stamps at a time, up to the date of its final substantial stoppage in November, 1883. Since that date it has only occasionally run a few stamps at a time on custom work. There was also a small reverberatory furnace, once built here to roast the concentrated sulphurets, which, after roasting, they tried to amalgamate. The ore contains not only a large percentage of pyrite, but also a good deal of arsenopyrite, or mispickel. The pyrite is said to have been generally poor in gold, while the arsenopyrite was very rich. All the granite, and all the sand of this region, is full of magnetic iron. There was a sixteen-stamp mill here in 1868, when Judge Sumner owned the mine.

A drain tunnel, two thousand feet long, starts from a point ten or twelve feet above the river, and taps the two hundred and forty-foot level at the main shaft in the Sumner Mine. The lowest level in the mine is about one hundred and twenty feet below this; but all that part of the mine is now filled with water.

There is here a group of veins. The main shaft is on the largest vein, which is said to have often been six to eight feet thick, with well defined walls. This vein has been called the Big Blue, and the eighty-stamp mill above described, has also sometimes gone under the same name.

At the main shaft there were steam hoisting works, and also two large steam, Cornish plunger, pumping engines. One of these pumping engines had a sixteen-inch, and the other a twelve-inch column.

But all these works were burned down, and the timbering of the shaft itself burned out, down to the eighty-foot level, early in November, 1883, since which time the mine has been idle. Unfortunately for the owner, it was not insured. The group of veins is chiefly in granite, but close to the irregular line of contact between that rock and a belt of highly metamorphosed slates, which lies just east. The general strike of the group is from north 10 degrees east, to north 30 degrees east, magnetic.

The mill was badly located, at some distance up the river from the mines, while a better location could have been had below, where a greater fall for both ore and water could have been obtained. The interior of the mill, also, while admirably designed in some respects, was badly so in others. Then the sulphurets, arsenical and otherwise, which were probably the richest portions of the ore, were after all mostly allowed to run off with the tailings into Kern River; and it is asserted to-day in Kernville, by men who

ought to know what the facts were, that ores, the battery pulp of which assayed $15 or $16 per ton, yielded only $2 or $3 per ton in the mill. Again, such costly steam hoisting and pumping works should not have been put up at the main shaft, when the Kern River, close by, could easily have been impressed to do the same work for far less cost.

About two miles below Kernville, alongside the road, on the west side of the North Fork, there is, for a distance of one hundred yards or more, a deposit of calcareous tufa. And there are said to be large bodies of crystalline limestone scattered about in many places in the mountains around here. There are no mines now on the east side of the North Fork. Small quantities of rich silver ores are said to have been found in the hills just south of the South Fork of Kern River, but there are no mines.

Caliente, Walker's Basin, Havilah, Hot Spring Valley, and Kernville are all of them almost in the one straight line, starting from Caliente in the order mentioned, the line running nearly north, magnetic.

The main stage road now (June 8, 1888) crosses both the North and South Forks of the Kern River, a little way above their junction. The North Fork, at the Ford, at this date, was about one hundred feet wide and two feet deep, with a current of about four miles per hour. The South Fork, which comes from the direction of Walker's Pass, carries, perhaps, one fourth as much water as the North Fork. From the junction of these two forks Hot Spring Valley extends several miles in a southerly direction. Erskine Creek comes into this valley from the east and southeast. Next west or southwest of Erskine Creek, comes Bodfish Cañon; and some five or six miles up this cañon is the locality (not visited) of Mr. Palmer's new mine, to which they are now (June seventh) building a road, and where they will put up two steam arrastras.

The springs in Hot Spring Valley have a maximum temperature of about 150 degrees Fahrenheit, and contain some sulphur and some alkaline salts.

Along the lower slopes of the mountains, just west of the town of Havilah, a belt of highly metamorphosed slates and limestones stretches for a considerable distance in a general northerly and southerly direction, and it is in the granite, just west of this belt, that most of the mines of this district are found.

The St. Charles vein, which crops at an altitude of about one thousand feet above the town, strikes about north 35 degrees east, magnetic, and dips 80 degrees or more to the northwest. Its thickness varies from a few inches to four and even six feet. The Darwin Mine is close by it, and both mines have been worked to depths of from thirty to seventy-five feet, but are idle now. They are in hard granite.

At the Confidence Mine, which is at about the same altitude, a tunnel runs some two hundred feet south 65 degrees west, magnetic, through soft granite to the vein, which strikes about north 20 degrees east, magnetic. The tunnel strikes the vein at a depth of a little over one hundred feet, and at the end of the tunnel a shaft goes down one hundred and ten feet deeper. The vein ranges from an inch or less to three feet or more in thickness, averaging perhaps ten inches. Twenty-five tons of ore from this mine, worked in the Sumner Mill, at Kernville, between May 25 and June 3, 1888, yielded $42 per ton in free gold. It is also estimated to contain some 4 per cent of sulphurets, which are largely arsenical, and which, when concentrated, are said to assay $120 per ton. The ore also, now and then, contains some calcite.

The Relief Mine, situated south of the Confidence, has a tunnel four hundred feet long, at the end of which there is a shaft two hundred and eighty feet deep.

A mine called the New World is being worked a little. But the whole extent of the mining operations going on at Havilah now is very small. There were formerly quite a number of five and ten-stamp mills at Havilah; but one after another, they have all been burned. Preparations were being made in June, 1888, however, for the building of another five-stamp mill.

From the summit, on the road between Havilah and Walker's Basin, a belt of metamorphic slates and limestones runs at least a mile or two southeasterly through the granite country; and in places these rocks are filled with crystals of garnet, calcite, quartz, and epidote.

Walker's Basin Creek comes into the Basin from the northeast, close by the site of the old Joe Walker Mill. About half a mile further up the creek there is said to be a small warm sulphur spring.

The Joe Walker Mine is situated so low down in the foothills at the northeastern edge of the basin, that it is impossible to drain it to any considerable depth by means of a tunnel. The country here is granite. The mine was discovered in 1865. A twenty-stamp steam mill was built here in 1866, and ran continuously till 1874, when it stopped, and has not run since. And after standing idle for some time it was finally sold and removed.

The mine is a quartz vein, striking north 45 degrees east, magnetic, and dipping 60 degrees southeast. Mr. D. L. Reese states that the vein ranged from two to twenty feet in thickness, but averaged about four and one half feet, and that the ore averaged from first to last about $24 per ton, though much of that from the upper portions of the mine went over $100 per ton.

There are two inclined shafts, or slopes, going down on the vein about three hundred and fifty or four hundred feet apart. Number one is the northeasterly and oldest slope, and is two hundred and fifty feet deep. Number two is three hundred and fifty feet deep. The three hundred and fifty-foot level runs southwest from Slope No. 2, about one hundred feet, and northeast about three hundred and twenty feet. The two hundred and fifty-foot level runs about thirty feet southwest, and six hundred feet northeast from Slope No. 1, and all the ground above this level, for that distance, is worked out. For the whole distance of one thousand and fifty feet, the vein, as left in the bottom of the mine, would average, Mr. Reese says, about four and one half feet thick. The vein is said to be well defined, with good smooth walls and clay gouges, the hanging-wall especially being very regular, smooth, and hard.

Mr. Reese thinks the ore contained about 3½ per cent of sulphurets, partly arsenical, and generally very rich in gold. Alfred Polkinghorne, son of the Cornish mining engineer who bought these concentrated sulphurets, told Mr. Reese that they yielded $3,000 per ton. The cause of the stoppage of the mine was its flooding with a greater volume of water than the pumps could handle. In Slope No. 1 there are two Cornish pumps, one of nine-inch, and the other of twelve-inch bore. In Slope No. 2 there are also two Cornish pumps, both of twelve-inch bore. The final catastrophe was the bursting of the pipe of one of the pumps at Slope No. 2. This, of course, at once destroyed one half the pumping power of the mine, as the pumps at this slope had to handle all the water. The remaining pump was then not able to keep the water down, and so the mine filled up. Mr. Reese says this mine yielded between $500,000 and $600,000 during the six years while Edward Burke was Superintendent. Slope No. 1 has two

compartments, each four by five feet inside of timbers. Slope No. 2 has three compartments. There is a drain tunnel eighty feet below the mouth of Slope No. 2, and the water now stands in the mine forty feet *below* that tunnel.

The Cumberland vein crosses the Joe Walker, striking about north 10 degrees east, magnetic, and dipping 70 degrees to 75 degrees easterly. It has a shaft down on it about seventy feet, and shows at the top about three feet, and at the bottom about five feet of quartz. Mr. Reese says the rock from this shaft yielded about $14 per ton. Farther south on the same vein, he says, there is a tunnel (not visited by the writer for want of time) three hundred feet long, where the vein averages twenty inches in thickness throughout, and the quartz averaged $12 per ton in gold. He thinks that the face of this tunnel is about one hundred and seventy-five feet beneath the surface.

It would seem from the above statements that the Joe Walker Mine, though it has now lain idle and full of water for a good many years, is nevertheless in all probability a good property, which will pay well for reopening whenever it shall be properly handled. The maximum depth reached, *i. e.*, three hundred and fifty feet, is insignificant. It is true that it is believed by some, that the quantity of water in this mine is altogether too great to handle. But if Mr. Reese's statements are true (and he is an old resident, well acquainted with the history of the mine), the two twelve-inch Cornish pumps at Slope No. 2 *were* handling it without difficulty until one of them burst its pipe. And the quantity of water which two such pumps can handle, though great, to be sure, is nevertheless by no means too great to allow of the profitable working of a vein four and one half feet thick which averages $24 per ton.

There is said to be a body of marble near Erskine Creek; also there is said to be a large body of limestone on Caliente Creek, some five or six miles above the railroad station.

The writer was also shown samples of pearlstone—a gray semi-obsidian—which were found somewhere among the hills in the near vicinity of Walker's Basin; but its exact locality was not ascertained. Its occurrence here is interesting, as no volcanic rocks were previously known to exist in this particular portion of the granite region. Its quantity is said to be great.

The belt of gypsum deposits referred to in the Mineral Resources of the United States, by Albert Williams, Jr., 1883, page 529, as "being scattered along the foothills from Caliente to Long Tom," is not in Los Angeles County, but is in Kern County. This belt was visited by the writer at several localities in the month of June last. There is unquestionably a great quantity of gypsum scattered through this belt; but no place was seen where there seemed to be any large amount of it that was very pure. There is, indeed, some very pure selenite; but this occurs only in thin seams, rarely an inch in thickness. Most of what has been called gypsum here appears to be a light-colored clay rock, or a very fine grained sandstone, with more or less (sometimes, indeed, a very high percentage) of gypsum scattered all through its mass in the form of very minute particles.

The cañon of the Kern River, which debouches from the high Sierra into the lower foothills, at a point about three miles east of Mr. John Barker's house, is extremely rugged and precipitous; and that part of the Sierra around its mouth is all a dark-colored syenitic granite.

The rich and somewhat noted locality of fossil sharks' teeth and bones, a few miles northwest of Mr. Barker's, and on the other side of the river,

was not visited by the writer, as at that time (June fourteenth) the river was still too high to be safely forded there.

A few days later, however, some sharks' teeth were found at another locality somewhat further northwest. At a point on Poso Creek, some fourteen miles by wagon road in a northerly direction from Bakersfield, lives Mr. Thomas Kelly, who has a cattle ranch. And it was on the top of a high hill, about three quarters of a mile south of his house, and from thirteen hundred to fourteen hundred feet above the sea, that quite a number of small sharks' teeth were found lying loosely scattered over the surface of the hill, evidently weathered out of the slowly disintegrating strata. It was in this same region that Professor W. P. Blake found sharks' teeth, and many casts of shells in 1853, and the whole formation has been referred to the miocene tertiary. The belt of the tertiary rocks is here very extensive, being from fifteen to twenty miles, or even more, in width, and rising, in places, to altitudes of two thousand or two thousand five hundred feet above the sea against the western flanks of the Sierra Nevada. They consist of sandstones, shales, and conglomerates, with occasional beds of limestone, generally impure (though some of it is said to make good lime), the whole having a general and very gentle southwesterly dip towards the valley.

No locality is known to the writer where these rocks, or any others along the western flank of the Sierra Nevada, that have been distinctly recognized as miocene in age, are much crushed, or folded, or upturned at any very high angles of dip.

From Tom Kelly's place we traveled about four miles up the valley of Poso Creek, to what is now known as the Widow Stark's place, where we first strike the southwestern edge of the granite in place. Here we left Poso Creek, and climbed the granite hills to the north a distance of some three miles to the Long Tom Mine. The latter is a vein of quartz in granite, striking about north 15 degrees west, magnetic, and dipping some 60 degrees southwest. A slope is down about five hundred feet on this vein, and it has been worked for about one hundred and twenty feet south from the slope.

Mr. Webb, the manager, states that it averaged about seven feet thick, and that where left in the bottom of the mine, it was twenty-three feet thick. The mine was first opened about 1860, and the ore first worked in arrastras. Then a ten-stamp mill, and later a twenty-stamp mill were erected on Poso Creek, about two miles southeasterly from the mines. At some time in April, 1888, work at the deep slope was stopped and the pump taken out, since which the water has risen in the mine (June twenty-third) to about the three hundred-foot level. They had a No. 5 Blake pump, which lifted the water to the mouth of the slope through a two-inch pipe. The hoisting engine was a small upright one. A round wire rope, three fourths of an inch in diameter, ran from the drum over a pulley, and all the ore and waste were hoisted in buckets holding about five hundred or six hundred pounds each—a poor outfit for such a mine.

Mr. Webb further says that the general average yield of the quartz was from $20 to $22 per ton in the mill, and that the mine has yielded some $800,000 or $900,00C. The hanging-wall is rather poor and requires some timbering. The mill is probably three hundred or four hundred feet lower than the mine.

A good deal of prospecting work in the way of small tunnels and open cuts has been done in the hills around here; but no other mine has ever been opened up to any considerable depth, and most of the veins are small,

and irregular in size, strike, and dip, though some very rich ore has been found.

Near Glenville, in Lynn Valley, Mr. Berry is now working a quartz mine with a five-stamp mill. But that locality was not visited for want of time.

The following observations concerning Kern County were principally made in the early part of May, 1870:

Entering the county from the north, at about the point where the old stage road from Visalia to Kernville crosses the White River, we are already among the granite foothills of the Greenhorn Mountain, that great, high spur of the Sierra Nevada, which stretches for so many miles southwesterly towards the valley, and occupies the whole region immediately north of the main Kern River, and west of its north fork.

Near the White River Crossing some prospecting had been done for gold, but no successful mining up to that date. The country continues to be chiefly granite, in which occasional veins of quartz occur.

On the road which we followed, the Greenhorn Mountain has two pretty distinctly marked crests or "summits" about seven and one half miles apart, the second or southeastern summit, which is the highest, being considerably higher than the summit of Walker's Pass itself, and probably not less than six thousand feet above the sea. At a point nearly midway between these two summits, and near where the road crosses a beautiful little branch of Cedar Creek, occurs a heavy body of metamorphic rocks. These rocks are generally hornblendic in character, and much of their stratification has been nearly or quite obliterated. But enough of it can still be seen in places to show not only that the rocks have been stratified, but also that they have been greatly disturbed, the beds being irregularly bent, twisted, broken, and crushed. This rock does not seem to pass by any gradual change in its texture, etc., into the granite, but appears to be separated from it by a line of demarcation, which is pretty distinct, and, in places, sharply drawn. For perhaps a mile beyond the point noted above, the road skirts the southeastern edge of this metamorphic rock.

Its margin then leaves the road and appears to bear off northeasterly through the mountain. How great the extent of this body of highly metamorphic rock may be, is not known, but it appears probable that it is an isolated patch, surrounded on all sides by granitic rocks. From the main summit of this ridge the road descends at once to Kernville, a distance of between nine and ten miles. It is upon crossing this summit of the Greenhorn Mountain that one passes here from the climate of the western to that of the eastern slope of the Sierra, and at the time of our transit, early in May, 1870, the contrast was sharp and sudden. The northwestern slope of the Greenhorn is heavily timbered, and was then plentifully watered by numerous little mountain streams. The nights were cold, and at McFarlane's Toll Gate, on Fulton Creek, at an altitude of about four thousand feet, the dew was heavy. No signs of cactus or any related plant were seen, and the vegetation generally resembled that of the western slope of the Sierra further north.

But on descending the southeastern slope the timber disappeared; no water was seen; the cacti were already in bloom; the days were hot; the nights not cold; and the air very dry; and at Kernville there was no dew even on the banks of the river.

On the way down the mountain towards Kernville, a great variety was noticed in the character of the granite. Some of it is soft, and some hard; some is very fine grained, and some is coarse; some is compact, and some is fissured and seamed in every direction; while here and there are masses

of very highly metamorphosed stratified rocks, which strike and dip in various directions, and among which mica-slate and hornblendic rocks are prominent.

About a mile above Kernville, on the right bank of the river, is a cluster of auriferous quartz veins in the granite. Several of these veins are nearly parallel, running about east northeast, true course. The Sherman Lead, otherwise known as the Bull Run Lead, strikes about north 53 degrees east, magnetic, and at the mouth of the Union shaft dips 65 degrees northwest. This mine was idle at the time of our visit, and I could not descend the shaft. I was informed by Mr. Staples, however, that it is about three hundred and seventeen feet deep, going down upon the pitch of the vein, which first dips flatly, and then more steeply on going down. The vein is said to be irregular in thickness, with rather ill-defined walls, and to have been about six inches thick at the surface of the ground, and four to five feet thick at the bottom of the shaft.

Two other veins, nearly parallel to this on the northwest, are the Jeff Davis and the Beauregard.

The Sumner Mine is on another vein, said to run northwesterly and southeasterly, apparently intersecting the first. At the time of our visit quartz was being taken from a point on the Sherman Lead, a little northeast of the Union Mine, and from a depth of not over forty or fifty feet, which was said to yield $30 per ton.

The rock from the Jeff Davis Mine was said to be yielding about $80 per ton, while that of the Beauregard was said to be richer still. Near these mines there are two quartz mills, one of ten stamps—idle at the time of our visit—and one of sixteen stamps running constantly.

Mr. Staples says he *knows* of more than $700,000 which have been taken from this locality, and that the total amount yielded, up to date (May 6, 1870), must be upwards of $1,000,000.

The quartz varies largely in the quantity of earthy matter which it contains. A little pyrite is present, but not much. Arsenopyrite, however, occurs in large quantity, and is probably auriferous, though no one here seemed to know whether it was or not.

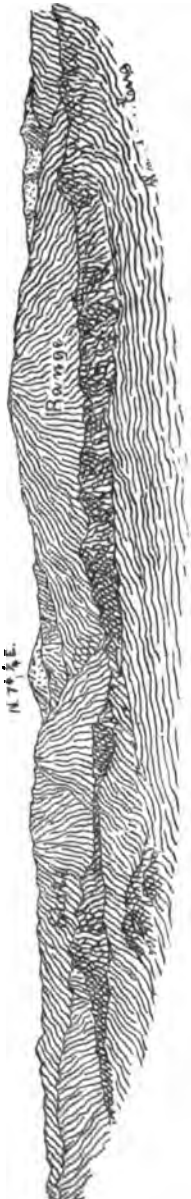
From Kernville our course was down the North Fork some two miles, and then up the valley of the South Fork of Kern River about twenty-two miles, to the mouth of Walkers Pass Creek, a branch coming in from the east.

Within this distance the valley of the South Fork ranges from half a mile to one and a half or two miles in width, and is perfectly flat and smooth with a very gentle grade. It is bordered on both sides by very steep granitic mountain ridges and peaks, which rise very abruptly from its sides to heights which I estimated at three thousand to four thousand feet above it. The granite varies much in character, and all through the surrounding mountains are scattered patches of very highly metamorphosed stratified rocks, which strike in various directions, and generally dip at very high angles, often standing nearly vertical. The granite itself sometimes contains flattened and elongated hornblendic nodules of a very dark color, contrasting with the inclosing rock; and there is often in moderate areas an approximate parallelism in the directions of the major sections of these nodules.

Much of all this strongly suggest the query, whether a great portion of the granite itself in this region be not really metamorphic.

From the mouth of Walkers Pass Creek to the summit of the pass is about eight miles. The grade here is heavier and the roads are hard traveling, as the soil consists chiefly of loose granitic sand. The mountains are

steep and very rocky, and show many sharp points. The rocks continue to be granitic with interspersed patches of very highly metamorphic rocks and suggestions of a possible metamorphic origin of the granite itself. Some of the granitic rock here is pretty coarse, and much of it contains but little mica. The country is very barren, and we found no feed for the animals here. Water, too, was very scarce, the springs being few and small.



From rock back of "Indian Wells," looking north 74¼ degrees east, magnetic. Distance to State Range probably fifty to sixty miles.

View from summit of Walkers Pass looking south 75 degrees east, magnetic.

From the summit of the pass down to the edge of the desert valley, which here stretches along the eastern foot of the Sierra, the distance is only about six or seven miles, and all along this portion of the road pebbles and bowlders of a considerable variety of very highly metamorphic rocks are plenty, as well as those of granite. Of many of these metamorphic rocks hornblende is a very large constituent, some of the fragments seeming to be a nearly pure and very coarsely crystalline, hornblendic, or pyroxenic rock.

Epidote is also common. The soil consists chiefly of granitic sand. At the eastern foot of the mountains we met the road from Owens Valley to Los Angeles, which passes through the desert away to the east and south of Tejon.

Directly in front of Walkers Pass to the east, is a large, rolling desert valley, beyond which rise the Coso and the Slate Ranges of Mountains. Camp No. 15 was at Indian Wells, in the western edge of the valley, at the foot of the Sierra, and twelve and three fourths miles from the summit of Walkers Pass. Here we stopped one day to rest the animals, and climbed to a point of observation upon a high granite hill, bearing north 61½ degrees west, magnetic, about one and one half miles from Indian Wells Station, and about eight hundred or nine hundred feet above it. From here the Sierra west of us appears to consist of metamorphic rocks and granite. From north, around by east to south, the mountains east of the valley so far as they can be seen (and the view is extensive), are everywhere more or less sprinkled with peculiarly black hills and patches which are undoubtedly volcanic, though little can be seen from here in the shape of the hills to suggest the form of craters. But here and there broad black belts running for miles down the mountain slopes from some of them, show all the characteristics of lava streams, so far as can be judged from such a distance. These rocks do not look like portions of a once continuous mass, but seem rather to have issued from numerous small and local fissures, distributed far and wide through the country. Notable among the volcanic appearances from here, is one which looks like a long and nearly straight black bluff, one hundred or two hundred feet, more or less, in height, facing the southwest, and running for a number of miles northwesterly and southeasterly along the northeastern portion of the valley, obliquely to the eastern front of the Sierra, and gradually approaching it towards the north as far as its course could be traced. I shall again refer to this bluff.

Far in the distance to the south, and very dim, probably considerably more than a hundred miles away, a high and conspicuous range of mountains limits the view. (Is this the San Bernardino Range?) In a hill some three fourths of a mile northwest of Indian Wells, is a heavy outcrop of hard crystalline limestone. At one point on the southern slope of this hill the strike of the limestone was north 80 degrees west, magnetic, and its dip 35 degrees to 40 degrees to the south, but its stratification is much disturbed, and the beds are bent and broken. On the top of the hill they lie nearly horizontal. Granite at one point comes up through the limestone to the surface like a dike. Small pieces of a dark-colored porphyritic rock are also plenty on the hill. A fresh fracture of the limestone is either gray or whitish in color, and does not exhibit the delicacy of its bedding. On the weathered surfaces the layers were seen to be often almost as thin and delicate as parallel sheets of paper. The weathered surfaces are also more or less stained with iron, and in places exhibit markings that look as if the limestone originally contained coarse crystals of actinolite, which is plenty in loose bowlders of hornblendic rock not far off. The limestone

seven miles below Kernville, where the aneroid barometer read two thousand five hundred and forty feet. The country here is all granite; much of it very feldspathic, and with still more feldspathic veins or dikes running through it. Judge Sumner's present mine is about two miles southwesterly from his arrastras, and five hundred or six hundred feet higher up amongst the hills north of the river, and about one fourth of a mile southeasterly from the site of the old and now deserted town of Keyesville. It is called the Mammoth claim, and consists of several veins of quartz, striking north 20 to 30 degrees east, and dipping some 75 degrees to the southeast, in a rather uniform and moderately coarse grained granite, much of which is more or less decomposed and rather soft. The course from here to the Sumner Mine is about north, magnetic. The veins at the Mammoth claim are irregular in size and richness; the largest one is at times twelve to fifteen feet wide, but in other places it pinches out entirely.

At the locality where Judge Sumner's arrastras now are, a twenty-stamp mill was built in 1865; but this mill ran only a very short time, and has since been entirely removed, except some of the foundations and the battery blocks, which still remain. The Mammoth vein has been worked to a depth of about seventy-five feet, for a distance of some six or eight hundred feet along the vein; but only a portion of it was taken out, and large bodies of quartz are still left standing there, which are, therefore, probably poor in quality.

Keyesville was at one time quite a thriving village, with a population of several hundred people. But it appears that though a good deal of rich ore was found, there was bad management, and the veins proved somewhat unreliable, and, therefore, the town went down.

About three and one half miles above Kernville, but on the opposite or left bank of the north fork of Kern River (which here flows south), is the Charles Harley Mill, of twenty stamps, which used to run by steam, but is now idle. About one and one half miles northeasterly from this mill, and some two thousand feet above it, near the highest crest of the so called Mineral Mountain, was the Harley Mine. This mine was a vein of quartz, striking northeasterly, and dipping southeasterly in granite. The "pay streak" is said by Mr. Jas. Morris, who worked there, to have been three to four feet thick. He also tells me that a tunnel was driven northeasterly on the vein some nine hundred feet, entirely through the mountain, passing some seventy-five feet beneath its highest crest; also that the mine was worked to a depth of about one hundred and fifty feet below this tunnel, and some very rich ore taken out. He further says that the mill was built in 1877; that it ran irregularly, off and on for some five years, perhaps making three years full time. There was a rich chimney here, but it gave out, and afterwards the average ore would not pay. They had a wire tramway here, built by Hallidie, with only a single wire rope three miles long, to bring their ore to the mill.

Nearly opposite this place, on the *right* bank of the river (*i. e.*, the North Fork), is a place where there are said to have existed, a few years ago, some very strong sulphur springs, where the sulphur used to accumulate to such an extent as to sometimes catch fire and burn on the surface of the ground. But the spot is now a dry, rough, sunken area, covered with a crust which probably contains various alkaline sulphates, with some free sulphur. There are several hot springs in the mouths of the cañons, on the east side of the North Fork of Kern River, opposite and a little above Kernville, and some of these contain more or less sulphur.

The dam on the North Fork of Kern River, from which the water was taken, some years ago, for the Sumner Mill, is about one and one fourth

miles above the mill; and from this dam a belt of extremely highly metamorphosed slates extends from one half to three fourths mile further up the river, striking from north 15 degrees west to north 50 degrees west, magnetic, and dipping 75 degrees or more to the southwest. No quartz of any account was seen in these slates.

The Sumner Mill is about one mile above the town of Kernville, on the right bank of the north fork of the river. It is an eighty-stamp mill, built in 1874 and 1875, and was run by a fifty-six-inch turbine water wheel. The ore from the mine was dumped from five-ton cars into a sixty-ton bin, or bunker, whence it fell and went through a fifteen by nine jaw-crusher of peculiar lever construction, and thence dropped into small cars running on a tramway the whole length of the building. From these cars it was dumped by hand into the separate hoppers of the automatic feeders, one to each battery of five stamps. From the batteries the pulp went to Hendy concentrators, one to each battery. But later on, two of the Hendy concentrators were replaced by four Frue vanners. Below the concentrators and vanners, there are six pans and three large settlers. The whole eighty stamps are said to have been run continuously for some two years, after first starting up in the spring of 1875. After that, the mill ran spasmodically, with more or less stamps at a time, up to the date of its final substantial stoppage in November, 1883. Since that date it has only occasionally run a few stamps at a time on custom work. There was also a small reverberatory furnace, once built here to roast the concentrated sulphurets, which, after roasting, they tried to amalgamate. The ore contains not only a large percentage of pyrite, but also a good deal of arsenopyrite, or mispickel. The pyrite is said to have been generally poor in gold, while the arsenopyrite was very rich. All the granite, and all the sand of this region, is full of magnetic iron. There was a sixteen-stamp mill here in 1868, when Judge Sumner owned the mine.

A drain tunnel, two thousand feet long, starts from a point ten or twelve feet above the river, and taps the two hundred and forty-foot level at the main shaft in the Sumner Mine. The lowest level in the mine is about one hundred and twenty feet below this; but all that part of the mine is now filled with water.

There is here a group of veins. The main shaft is on the largest vein, which is said to have often been six to eight feet thick, with well defined walls. This vein has been called the Big Blue, and the eighty-stamp mill above described, has also sometimes gone under the same name.

At the main shaft there were steam hoisting works, and also two large steam, Cornish plunger, pumping engines. One of these pumping engines had a sixteen-inch, and the other a twelve-inch column.

But all these works were burned down, and the timbering of the shaft itself burned out, down to the eighty-foot level, early in November, 1883, since which time the mine has been idle. Unfortunately for the owner, it was not insured. The group of veins is chiefly in granite, but close to the irregular line of contact between that rock and a belt of highly metamorphosed slates, which lies just east. The general strike of the group is from north 10 degrees east, to north 30 degrees east, magnetic.

The mill was badly located, at some distance up the river from the mines, while a better location could have been had below, where a greater fall for both ore and water could have been obtained. The interior of the mill, also, while admirably designed in some respects, was badly so in others. Then the sulphurets, arsenical and otherwise, which were probably the richest portions of the ore, were after all mostly allowed to run off with the tailings into Kern River; and it is asserted to-day in Kernville, by men who

iron being also met with. In Paradise Valley, about five miles from the Sulphur Banks, a shaft has been sunk to a depth of sixty feet on a ledge of quartzite. The ore, which is much copper stained, carries considerable pyrites, and assays from $3 to $9 in gold per ton, with a small percentage of silver. Gold-bearing quartz has been observed in the vicinity of Mount St. Helena, also near the Bradford Quicksilver Mine, and at a point between Anderson Springs and the Geysers. The croppings of these quartz veins contain a small amount of silver.

One mile east of Bradford much copper float is to be seen, and near Harbin Springs a shaft has been sunk to a depth of sixty feet in a cupriferous vein, but the ore is of too low a grade to warrant further sinking.

BORAX.

Situated about a half mile east of the lower end of Clear Lake is a pond, the water of which is highly charged with the biborate of soda. During the dry season this water mostly disappears, through evaporation, and the borax crystallizing out is found in the mud on the margin of the pond. Twenty-five years ago large quantities of this salt were manufactured here, the first made in the United States said to have been produced at this place. There has, however, no work been done here for a long time, the business having been given up on the discovery of more extensive and productive salines in the southern part of the State and Nevada.

CHROME IRON.

In Jerusalem Valley, eight miles east of Middletown, occur several large veins carrying chromic iron. Owing to the cost of transportation to market, nothing except a little prospecting work has been done on these deposits. The presence of this mineral has been observed, also, in the serpentine near the Bradford Mine.

SULPHUR.

Some twenty years ago a good, merchantable article of sulphur was produced in considerable quantities from deposits of this mineral, several of which occur on and near the eastern shore of Clear Lake, and at some of which solfataric action is still going on. Works for the distillation of the crude material were put up at one of these deposits, and run for several years, but the cheapness of the imported commodity rendering operations here unprofitable, they were finally suspended, and have not since been resumed.

NATURAL GAS.

The water obtained by artesian boring, on the outskirts of Kelseyville, proves so highly charged with natural gas that the latter burns readily. The well put down here is one hundred and fifty-seven feet deep, and being lined to within a few feet of the bottom, this gas evidently comes from a lower stratum. Five other wells sunk in this vicinity to a depth of sixteen feet each, though they yield no water, emit gas, which under a slight pressure burns freely, with a colorless flame, giving off the odor of sulphuretted hydrogen. These wells are in an adobe soil, about two hundred feet above the level of Clear Lake. This gas is to be collected and utilized in a fruit drier. A well put down near Upper Lake also gives off natural gas.

MINERAL SPRINGS.

A large number of mineral springs occur in different parts of this county. Several of these springs, by reason of the medicinal properties of their waters, have become places of popular resort.

ADAMS SPRINGS.

These springs are located in the mountains, eight miles south of Clear Lake, at an elevation of three thousand three hundred feet above sea level. An analysis of their waters, made by Prof. Price, shows them to contain the following ingredients:

Carbonate of lime, grains to the gallon	28.714
Carbonate of magnesia, grains to the gallon	99.022
Carbonate of soda, grains to the gallon	57.036
Carbonate of iron, grains to the gallon	0.517
Carbonate of sodium, grains to the gallon	4.112
Silica, grains to the gallon	7.218
Organic matter, grains to the gallon	2.811
Salts of potash	Trace.
Nitric acid	Trace.
Total grains in one gallon	199.430

One gallon gave three hundred and four cubic inches of carbonic acid gas.

ALLEN SPRINGS.

These springs, six in number, are located near the head of Cache Creek, at an elevation of one thousand eight hundred feet above tide water. Their waters are alkaline, saline, and chalybeate.

ANDERSON SPRINGS.

Four miles from Middletown, at the head of Lacoma Valley, are located these springs, nine in number. The waters here are sulphuretted, carbonated, and chalybeate, some of these springs being hot and some cold.

BARTLETT SPRINGS.

These springs are situated in the extreme northeastern corner of the county; their waters, sulphuretted and carbonated, are largely bottled for export.

BORAX SPRINGS.

These springs, so called because the waters contain biborate of soda, are located on the edge of Clear Lake, near the sulphur banks.

BONANZA SPRINGS.

Lying between Howard and Siegler Springs, are the three Bonanza Springs, with sulphuretted and chalybeate waters.

HARBIN SPRINGS.

These springs lie four miles northwest of Middletown, at an elevation of one thousand seven hundred and fifty feet above sea level. The waters are saline and sulphuretted, having a temperature of 118 degrees Fahrenheit.

HIGHLAND SPRINGS.

There are at this place, which has an elevation of one thousand seven hundred feet above sea level, some twenty-five springs. Prof. Rising made analyses of the water of five of them, with the following result:

	Seltzer Spring.	Dutch Spring.	Magic Spring.	Neptune Spring.	Diana Spring.
Sodium carbonate	8.87	12.72	15.10	22.10	24.08
Magnesium carbonate	20.67	40.08	41.63	89.87	79.95
Calcium carbonate	34.76	39.80	35.02	77.75	73.27
Potassium carbonate	0.38	0.58	0.42	0.80	1.46
Manganese carbonate	trace.	trace.	trace.	trace.	trace.
Iron carbonate	0.92	0.98	0.78	1.37	1.40
Sodium chloride	0.72	1.65	1.28	1.68	1.89
Alumina	1.56	0.11	0.17	1.37	0.23
Silica	5.24	7.12	7.39	8.42	8.79
Organic matter	trace.	trace.	trace.	trace.	trace.
Barium bicarbonate				0.17	0.20
Lithium bicarbonate				trace.	trace.
Boracic acid				0.47	*
Total grains to the gallon	73.12	103.04	101.79	133.90	191.47
Cubic inches carbonic acid gas to the gallon	212.20	184.80	156.80	94.12	71.85

* Undetermined.

HOWARD SPRINGS.

These springs, fourteen in number, are situated at the lower end of Siegler Valley, six miles from Lower Lake, at an elevation of two thousand two hundred feet above sea level. Their temperatures range from 58 degrees to 109 degrees Fahrenheit. The waters are saline and chalybeate.

MILLS SPRINGS.

One mile above Anderson Springs are located what are known as the Mills Springs, four in number. These waters are saline and sulphuretted. Temperature, 170 degrees Fahrenheit.

SARATOGA SPRINGS.

These springs are located fourteen miles northwest of Lakeport, at which point are found sulphur, soda, iron, and magnesian waters.

SIEGLER SPRINGS.

These springs lie at the north end of Siegler Valley, at an elevation of two thousand three hundred and seventy-two feet above sea level. The waters have a temperature of 200 degrees Fahrenheit, and are said to contain magnesia, iron, borax, and arsenic. The water of one of the springs has a decided taste of petroleum.

SODA BAY.

On the west shore of Clear Lake a spring breaks out in the lake. No analysis of the water is to be had, but it is evidently carbonated and contains much iron. The escape of carbonic acid gas here raises the water

nearly a foot, and gives it the appearance of boiling. The main spring covers an area of one square yard. Bubbles of gas may be seen rising through the water of the lake for several yards in every direction.

WITTER SPRINGS.

These springs, several in number, are situated about six miles from the town of Upper Lake, at an elevation of one thousand seven hundred feet above the sea. Their waters are sulphuretted and chalybeate.

LASSEN COUNTY.

This county is named after Peter Lassen, an early settler in the Upper Sacramento Valley, where he obtained from the Mexican Government and owned at the time of his death a large tract of land. This brave and hardy pioneer was killed by the Piute Indians in the spring of 1859, while prospecting for silver mines in the Black Rock region, northwestern Nevada. The county named after him was erected in 1864, from the eastern parts of Shasta and Plumas Counties, there having been included within its boundaries a strip of territory, that prior to 1862 had been claimed by the Territory of Nevada, constituting the western half of Roop County, in that Territory. Lassen County is bounded by Modoc County on the north, the State of Nevada on the east, Plumas on the south and southwest, and by Plumas and Shasta on the west.

This is one of California's trans-Sierra counties, being situated wholly to the east of the Sierra Nevada Mountains. The western third of Lassen, reaching at some points the summit of the Sierra, is elevated and rugged, the remainder consisting of valleys, alkali flats, and sage plains, over which are scattered numerous short mountain chains, straggling hills, and isolated buttes. Although much of the soil is sandy and barren, or rendered unproductive through the presence of alkaline deposits, the most of it is naturally rich, and can be made to produce good crops of grain and the hardier fruits, by the aid of irrigation. Without this, however, these products cannot be matured, owing to the shortness of the warm season, the elevation of this region ranging from four to eight thousand feet. While fruit, vegetables, and the cereals are grown here to some extent, stock raising forms the principal business of the inhabitants. There are heavy forests of pine and spruce on the mountains to the west, but the rest of the county contains only a very sparse growth of pine and juniper, fit only for fuel. Lassen, as a whole, is but poorly watered. Pitt River, making a violent detour from its regular course, dips into the northwestern angle of the county. Aside from this, Clear Creek, a southerly branch of Pitt River, Pine Creek, running south into Eagle Lake, and Susan River, rising in the Sierra and flowing southeast into Honey Lake, constitute the principal streams in this county. Many small creeks, issuing from the mountains, affording on their way means for much irrigation, are swallowed up after making their way a short distance out into the arid plains. Although there are a number of small lakes in the high Sierra, the only bodies of water of any size in the county are Eagle and Honey Lakes, each, when full, covering an area of about fifty square miles. The former is very deep, but the latter is shallow, and sometimes nearly dries up.

MINES AND MINERALS.

Although the mineral resources of this county are considerable, and much prospecting, as well as work, has been done there since an early day, developments, owing to the many drawbacks under which they have had to be prosecuted, have proceeded slowly. Deposits of silver were supposed to exist in that region even before the Comstock lode was discovered, and it was while out on an expedition in search of that metal that Peter Lassen lost his life. While these early explorations led to the finding of many gold and silver-bearing lodes, some of which were outfitted with plant, the bullion product of the county has never been large.

EVENING STAR QUARTZ MINE.

In the Hayden Hill District, situated in the northwestern part of the county, where only much work is now being done, several mines are in course of active development. Here, on Diamond Mountain, the Evening Star Company are working six men—four in the mine and two in the mill, which carries ten stamps. This claim, located in 1870, is of the usual dimensions—fifteen hundred feet by six hundred; ore, gold bearing; size of vein, eighteen inches wide; strike, north and south; pitch, nearly perpendicular; opened by tunnel one thousand eight hundred feet long, run at right angles to the vein and cutting it at a vertical depth of two hundred and forty-six feet, and by shaft raised from inner extremity of the tunnel to the surface; pay shoot, three hundred feet long; walls, talc. Shaft and tunnel timbered throughout; pine suitable for the purpose being found near at hand and supplied at 4 cents per foot. Cost of tunnel, $10 per linear foot; cost of ore extraction, $5 60 per ton; cost of wagon transportation of ore from mine to mill, $1 25 per ton. Character of ore, quartz mixed with talcose rock; method of recovery, amalgamation in battery and collection on outside silvered plates; inclination to the foot, apron one and a half inches; sluice plates, one inch. Sulphurets not saved. Quantity of water used in battery, one inch, delivered under a four-inch pressure. Motive power, water brought through a ditch one fourth of a mile long and delivered on a thirty-five-foot overshot wheel. Wages paid, board included, miners, $2 84 per day; millmen, $40 per month.

Altitude	6,300 feet.
Length of ore shoot	300 feet.
Vertical depth reached in mine	281 feet.
Cost of mining	$5 60 per ton.
Cost of running tunnel	$10 per foot.
Number of stamps	10
Weight of stamps	650 pounds.
Drop of stamps	6 inches.
Drops	90 per minute.
Duty of stamp	1½ tons in twenty-four hours.
Shoes and dies	Iron.
Cost of shoes and dies	6 cents per pound.
Size and character of screens	Slot punched, No. 11.
Dimension of apron	4 by 8 feet.
Width of sluice	20 inches.
Length of sluice	8 feet.
Ore feeders	2 Challenge.
Percentage of recovery saved in battery	66
Percentage of recovery saved on plates	34
Men employed in mine	4
Men employed in mill	2

GOLDEN EAGLE QUARTZ MINE.

This mine, situated in the vicinity of the Evening Star, comprises one thousand one hundred feet by six hundred feet, located on a vein of gold-bearing quartz having an average thickness of two feet; a northeasterly and southwesterly course, and a westerly dip of 45 degrees; walls, talc, opened by shaft and tunnel; length of latter, one hundred and seventy feet, intersecting vein at a depth of fifty feet; depth of shaft, two hundred and twenty-five feet, vertical. Cost of driving tunnel, $1 50 per foot; cost of sinking shaft, the same. Ore shoot, one hundred and twenty-eight feet in length. Cost of mining, $3 per ton; cost of milling ore, $1 25 per ton; ore transported by wagons one mile. Cost of timber, 4 cents per running foot; pine suitable for the purpose growing within one and one half miles of the mine. The mine is equipped with a five-stamp mill. Weight of stamps, six hundred pounds; drop, six inches; seventy drops per minute. Size of apron plate, four feet by eight feet. Width of sluice, twelve inches; length to each battery, seven feet.

Altitude	6,400 feet.
Number of stamps	5
Weight of stamp	600 pounds.
Drop of stamps	6 inches; 70 per minute.
Duty of stamp	1.6 tons in twenty-four hours.
Length of ore shoot	128 feet.
Depth of ore shaft vertically	225 feet.
Cost of running tunnel	$1 50 per foot.
Cost of sinking ore shaft	$1 50 per foot.
Length of tunnel	170 feet.
Vertical depth from surface reached by tunnel	50 feet.
Shoes and dies	Iron.
Size of screens	Slot, No. 7.
Dimensions of apron	4 by 8 feet.
Width of sluice	12 inches.
Length of sluice	70 feet.
Kind of feeder	Hand.
Percentage of recovery saved in battery	66
Percentage of recovery saved on plates	34
Cost of milling	$1 25 per ton.
Cost of mining	$3 per ton.
Number of men in mill	2
Number of men in mine	4
Average wages in mine	$2 84 per day.
Average wages in mill	$3 per day.
In tunnel, number of feet run per day	3
In shaft, number of feet sunk per day	3

The other mining claims being prospected in this district nearly all show promising indications, some of them being already well opened and having yielded considerable quantities of good ore. Several other mining districts were organized in different parts of this county many years ago. In these districts a great many claims were at the time located and much desultory work afterwards done upon them. But so little has been done in them of late years that the most of these districts may be considered practically abandoned, and that without anything determinate of their value having been reached. Mineral springs, hot and cold, are met with in different parts of this county. The most notable of these consist of a group of thermals situated on the border of Honey Lake. One of these springs, a deep pool, ten feet across, boils violently; the water being thrown to a height of several feet. The temperature of these springs varies from tepid to boiling hot, the group sending off perpetually a cloud of steam. They are all more or less mineralized, their waters being impregnated with iron, salt, soda, and sulphur in varying proportions. Besides the precious metals, Lassen

is known to contain many of the more common metals and minerals, but under what conditions has not been determined, as none of these have ever been utilized or made the objects of careful search.

LOS ANGELES COUNTY.

This county is bounded by Kern on the north, by San Bernardino and San Diego on the east, by the Pacific Ocean on the south and southwest, and by Ventura County on the west.

PADER MINE.

This mine is situated on the eastern spur of Gleason Mountain, in Gleason Mountain Mining District. Elevation, six thousand feet above the level of the sea. Temperature in July, 78 degrees Fahrenheit.

This mine lies about six miles south of Acton Station, on the Southern Pacific Railroad. The ledge runs northwest and southeast, cropping out for a distance of two thousand feet, and dips to the northeast into the hill at about an angle of 80 degrees. The hanging-wall and foot-wall are clay schists. Plenty of wood and water for all mining purposes are on the property.

At about the center of this ledge there is a shaft sunk, on the ledge, to a depth of forty-six feet, at the bottom of which the ledge is twenty-nine inches in width.

NEW YORK MINE

Is situated in the Cedar Mining District, at an elevation of four thousand feet above sea level. The ledge runs northeast and southwest, and dips to the east. A two hundred-foot tunnel running in from the west taps the ledge at a depth of three hundred feet below the surface, at the extreme northwest end of the claim. At this point the ledge is broken up and the ore channel filled with conglomerate ledge matter. At the intersection of the tunnel with the ledge, a drift was run southeasterly on the ledge a distance of three hundred and sixty feet. At different points on the ledge uprises have been made of from fifty to seventy-five feet in height. The average width of the ledge is about two and one half feet.

In connection with this mine, one and one half miles south of it, is O'Riley's mill. This mill has been run continuously for the last eighteen months. Water used in battery, one inch. Ore crushed from this mine yielded at this mill $18 per ton. The mortar is five feet long, and one foot four inches in width. Sluices contain amalgamated plates, thirty feet long by six inches wide, and have an inclination of one foot in five. Six men are employed in the mill, with wages of $3 per day each. Two cords of wood are used daily at the mill, at a cost of $5 per cord.

There are four men in the mine at $3 per day, and five men at $4 per day. Cost of transporting ore from mine to mill, about 50 cents per ton. Where the ledge narrows the ore becomes richer, yielding from $25 to $40 per ton. The ledge is eight inches wide at the narrowest point, and seven feet at the widest.

THE RED ROVER MINE.

Situated about fifty-five miles north of Los Angeles. Elevation, four thousand feet above sea level. The ledge runs northwest and southeast,

and dips to the southwest at about 40 degrees. This mine lies in the center of the Sierra Madre Range, in the low hills, and in the same belt as the New York Mine, being one fourth of a mile west of it. There is on this ledge a double compartment shaft, reaching to a depth of two hundred and twenty feet. At the depth of one hundred feet, there is a level run to the northwest on the main ledge for a distance of two hundred and forty-five feet. After running one hundred and forty-five feet, the country rock breaks up and the ledge disappears. One hundred feet from this shaft on the first level is sunk a shaft seventy feet deep, all in good ore. The two hundred-foot level within twenty feet of the bottom of the shaft is run on the ledge northwest for a distance of two hundred feet, all in ore. There are no levels opened to the southeast on the ledge.

Nearly all the ore from the two hundred-foot level to the surface was stoped out a great many years ago, and worked at a mill known as the Walker Mill. In making these developments below the one hundred-foot level, one thousand five hundred tons of ore were taken out, and are now on the dumps, and is said to average $10 per ton in free gold. Very little timbering is required. Water is piped for a distance of two and one quarter miles to the mine. There are being erected two National rocker quartz mills on the property, each with a capacity of ten tons in twenty-four hours.

SILVER MOUNTAIN MINING DISTRICT.

This district is twenty-two miles north of Newhall, on the Southern Pacific Railroad, and has an elevation of three thousand two hundred feet above the level of the sea. There is a big belt of quartzite extending northeast and southwest for seven miles in length by two in width.

By running cuts and tunnels upon this quartzite a large body of ore was discovered, containing silver and lead; so far as developments have been made, it is not determined whether it is a ledge or a large ore deposit. Timber is plentiful on the property, and there is an abundance of water at a distance of two miles south of the mine. Seven men are employed in the mine at the rate of $3 per day each.

CASTACA PLACER DIGGINGS.

These diggings are situated about forty miles northwest of Los Angeles, ten miles north from the Newhall Station, on the Southern Pacific Railroad, and four miles north of Castaca Station, on the branch railroad extending from Newhall to Santa Barbara. The average elevation of this placer area is one thousand four hundred and fifty-five feet. This gold belt lies on the southern slope of the Sierra Madre, and extends southeast and northwest for a distance of ten miles, and is eight miles in width. This tract is situated in T. 5 N., R. 16 W., S. B. M. The gravel averages ninety feet in depth. The inclination from the highest to the lowest point of gravel averages one hundred and fifty feet to the mile. The gravel dips to the south with the bedrock. This deposit is cut through by numerous small gulches running in all directions, each gulch having been worked in a small way off and on for the last thirty years. A portion of this ground has been purchased by an English syndicate.

According to the tests made by them with a dry washer, before the purchase was made, the gravel, it is stated, gave an average yield of 36 cents, gold, per cubic yard. Of course the dry washer does not separate the gold from the clay and lumpy portion of the gravel.

The syndicate referred to above is constructing a ditch from Elizabeth Cañon, twelve miles distant, to the gravel deposit. The source of the water is in Elizabeth Lakes, of which there are three, situated on the northern slope of the Sierra Madre Mountains. The upper lake is at an elevation of three thousand one hundred and sixty feet, and fifteen miles northeast of the head of the ditch. This water can be put on the highest point of gravel with a four hundred-foot pressure. For two months, in summer, the water decreases to about two hundred inches. In the height of the rainy season the quantity of water may reach four thousand inches.

SAN FILICIANA PLACER DIGGINGS

Are situated at an elevation of two thousand one hundred feet, between Castaca Diggings and Piru Creek, twelve miles northwest of Newhall, on the Southern Pacific Railroad. This deposit of gravel, for an area of eight by four miles in extent, is supposed to average fifteen feet in depth, and is cut through by gulches and cañons. Each cañon throughout this area has been more or less worked for the last ten years.

During the period from 1810 to 1840, José Bermudes and Francisco Lopez superintended the Mission Indians in working these gravel deposits. In 1842, finding that these deposits, though worked in a crude manner, paid exceedingly well, the Mexican Government was petitioned to consider the territory between Piru Creek and the Soledad Cañon, and extending west of the Mojave Desert, mineral land; and that no grant be extended taking in that territory. This petition was granted by the Government. The most extensive mining operations carried on in this belt of gravel were in 1854, when Francisco Garcia took out of the San Filiciana Gulch in one season $65,000 in gold.

The reason why this cañon was worked more than the others is that at its head there is a spring that flows one and a half inches of water. This water was used at intervals until ten years since, when Mr. W. M. Jenkins secured the right of its use, and after conducting it to a reservoir, employs t for hydraulic purposes. It is stated that the yield is 65 cents per cubic yard for gravel washed. At the junction of Palomas Cañon and Sheep Creek, behind a bowlder extending out from a belt, a prospector found one piece of gold that was worth $1,900. Every rainy season Mexicans can be seen in Palomas Cañon prospecting for gold.

In 1882 Mr. J. R. Holmes placered in Cave Cañon, which connects with the San Filiciana, and worked two hundred cubic yards of gravel, which yielded $1 per cubic yard. So far as this gravel belt has been examined, both on the high hills and down in the cañons, the gravel seems to be free from large bowlders. The black sand containing the gold is composed of magnetic iron and iron oxide. The bedrock is slate.

It is believed that the waters of Piru Creek can be brought to this ground with a pressure of from one hundred feet to six hundred feet above the highest point of the gravel. The underflow and the overflow of Piru Creek amounts in dry seasons to about one thousand miner's inches. The outlet for the debris from this placer belt is exceptionally fine, and the slickens will not interfere in any way with agriculture or navigation. On the south side, parallel to the gravel belt, are good oil indications.

There are at Castaca and San Filiciana sixteen men at work, with Freeman's dry process gold separators; and it is stated they are washing out from $1 50 to $5 in gold each, per day. These dry washers are made in two sizes, viz.: of fifty and one hundred tons. Washers weigh one hundred and twenty pounds. The machines are so constructed that they can

be readily taken apart for the purpose of packing. There is also a small prospecting machine made, weighing twenty-seven pounds, and known as Freeman's Baby Dry Washer. To the big machine a blacksmith's forge can be attached.

In operating the machine the gravel is thrown into a receiving hopper and falls upon a screen, which is jarred by a crank shaft striking a bumper at every revolution. The larger stones pass off and the finer dirt feeds into another hopper, and is fed from this upon an apron, from which the waste is carried off by the action of the air; the air being forced into an air chest under the apron by means of a double bellows. As the bellows are put in motion, rapidly succeeding currents of air are forced into the air chest and retained until sufficient pressure is produced to force the air through the apron, a one hundred and twenty-mesh wire screen, underneath which is a larger canvas. The latter assures an even flow of air throughout the entire surface of the apron—the air expanding in the chest is forced through the apron rapidly, slightly raising the gravel therefrom, allowing the gold to settle on the riffles.

LOS ANGELES COUNTY.

By W. A. Goodyear, Assistant in the Field.

Some of what follows concerning this county is taken, as the text will show, from notes made in 1872 and 1874, as well as later, in 1887 and 1888:

Following the old stage road near the coast, from San Diego northwesterly into Los Angeles County, the road shortly after leaving San Mateo climbs the hills, over which it passes for some two or three miles, and then descends again to the beach, which it then continues to follow for several miles further, *i. e.*, to within two and one half or three miles of San Juan Capistrano. For the whole of this distance where the road follows the beach, the mesa fronts the shore in a line of almost vertical bluffs, ranging from seventy-five feet to one hundred feet in height, consisting of unaltered sandstones and clay shales, with occasional thin streaks of half consolidated gravel, and now and then a thin layer of argillaceous limestone. These beds appear to be nearly horizontal, but in reality they dip very gently towards the northeast. Towards the south, where the road after crossing the hills first descends to the beach, the angle of this dip is probably nowhere more than 4 degrees or 5 degrees. But it appears to increase somewhat as we approach the mouth of the San Juan Creek, where in some places it may be as high as 10 degrees or 12 degrees. So far as seen, the soil on this portion of the mesa is generally adobe, which much of the way seems to be very deep.

For some distance northwest from the mouth of San Juan Creek, the bluffs along the beach are near one hundred feet in height, and consist mainly of heavy-bedded sandstones (with some thin layers intercalated here and there), the whole dipping to the northeast, at angles varying from 10 degrees to 20 degrees, and sometimes even more. Immediately north of the mouth of the creek, these sandstones are overlaid unconformably by a heavy mass (at places thirty-five feet to forty feet or more in depth) of consolidated gravel, whose pebbles, some of them forty or fifty pounds in weight, consist of granitoid and highly metamorphic rocks, derived from the Santa Ana Range to the east.

The hills along the sides of the valley for a considerable distance from the ocean up the San Juan Creek are terraced, and in places three or four

separate terraces can be distinguished one above the other, which, however, are not continuous for any considerable distance. In the hills a mile or two almost due north from San Juan Capistrano, the bedding of the rocks where well exposed in the hillsides is horizontal.

The hills on the southeast side of the creek, some two or three miles above San Juan Capistrano, were found by Dr. Cooper to consist of metamorphic slates, overlaid, however, in places by more or less of a tertiary formation of very irregular thickness. But, with this exception, the country immediately bordering on the creek for a distance of nine or ten miles above San Juan Capistrano consists entirely of unaltered rocks, belonging, as Dr. Cooper thinks, to the pliocene or miocene tertiary. These rocks are generally not upturned at any high angles of dip. Large areas lie almost exactly horizontal; and yet a very large portion of them has been slightly disturbed, and dips from 5 degrees to 10 degrees or 12 degrees are not infrequent. This disturbance, though not large in amount, seems to have been locally quite irregular, and the strike and dip are sometimes in one direction and sometimes in another. As already stated, however, the general dip near the seashore is northeasterly; while farther back, near the foot of the mountains, the reverse is the case, the prevailing dip there being southwesterly.

At two or three points along up the creek heavy beds of coarse, gravelly conglomerate were noticed, unconformably overlying the fine grained sandstones, just as in the bluff at the mouth of the creek. At a point on the left bank of the creek, eleven or twelve miles above San Juan Capistrano, the rock is a rather thin-bedded, gravelly conglomerate, dipping some 15 degrees to the southwest, and containing some rather poorly preserved fossil shells, of which Dr. Cooper obtained a few specimens—enough to satisfy him that the rock is miocene.

A little over one mile farther up the cañon, we again find very highly metamorphosed rocks in place. Many of these rocks, on weathering and becoming partially decomposed, present the same peculiar cavernous or amygdaloidal appearance first noticed at the mouth of the San Diego Cañon, about two miles above the Old Mission, and which is so strongly suggestive of volcanic origin. And, indeed, it is by no means certain that some of them are not volcanic dikes. But in any case they have been so highly altered as greatly to disguise their original character. The bed of the cañon here is filled with a great variety of bowlders of metamorphic slates, etc., with granitic, dioritic, and porphyritic rocks, which have come from the mountains above. About one mile further up the cañon, *i. e.*, some twelve or thirteen miles from San Juan Capistrano, are the hot springs, called Agua Caliente. The waters of these springs contain some sulphur, and have a temperature estimated at about 130 degrees Fahrenheit. They are not far from eight hundred feet above the sea.

From all that I could learn, it is more than probable that the shaking down of the tower on the old Mission Church at San Juan Capistrano, by the earthquake of 1812, was not due so much to any excessive severity of the shock itself, though it was undoubtedly a pretty strong one, as it was to the fact that the church was poorly built, and of very poor material. Certainly, if the shock had been a *very* heavy one, it would not have left the walls of the edifice themselves standing as they do to-day (1872). The material used in its construction was a decidedly soft, tertiary sandstone, and the walls were mostly rubble work, only the corners being faced with cut stone. In the interior of the church, the corners and pilasters were built of a rather handsome bluish, micaceous sandstone, somewhat resembling the Angel Island sandstone in appearance, but much softer and

very weak. On the top of this poor construction, with exceptionally bad materials, were placed a tile roof, and a very heavy bell tower of considerable height. The whole building was thus most admirably adapted to serve as a deathtrap in a case of an earthquake. And it was the falling of this tower into the body of the church on a Sunday, during divine service, which killed, according to Father Mutt, some thirty-five or forty people. The outside walls of the structure were mostly left standing. But if the shock had been anything like as heavy as some which have been experienced by the present writer, they, too, would have crumbled into a confused mass of rubbish.

May 15, 1872, we camped at C. B. Rawson's place, on Los Alisos Creek. This was on the northwest quarter of Sec. 34, T. 6 S., R. 8 W., S. B. M. The next morning I started off nearly west among the hills, crossed the Cañon de la Laguna, climbed the hills beyond, and continued my westerly course to the highest point of the group of coast hills between Los Alisos Creek and the Anaheim Plain. This point is some one thousand three hundred feet above the sea, and bears about south 76 degrees west, magnetic, distant in an air line some five or six miles from Rawson's.

The first ridge crossed, lying between Rawson's and the Cañon de la Laguna, consists chiefly of calcareous sandstones, containing streaks here and there of bluish crystallized calcite. The stratification, where seen, was not very well exposed; but the strike is probably northerly or northwesterly, and the dip easterly, at rather high angles. The cluster of hills west of the Cañon de la Laguna, of which the highest point was reached, as above stated, looks from the summit like a somewhat independent uplift, the strata in the eastern portion of it dipping towards the east, those near the seashore dipping westerly, and those along the north side of it dipping northerly towards the Anaheim Valley. Some of these appearances, however, may have been deceptive, as it is often difficult to judge correctly of the strike and dip of strata from a distance. The rocks here are exclusively unaltered sandstones, yellowish brown in color, and precisely similar in appearance to those in the lower hills to the north of the Mount Diablo coal mines, in Contra Costa County. They are probably of tertiary origin, and many of them are more or less calcareous. But no fossils were found here. The amount of dip in various directions in these hills ranges from 15 to 30 degrees.

The following day we traveled from Rawson's some five miles up Los Alisos Creek, where we separated, Dr. Cooper walking some two or three miles further up the creek to the foot of the mountains, while I climbed a hill to the north. On the top of this hill an impure limestone strikes northwesterly and dips southwesterly about 10 or 12 degrees. And in this limestone I found some fossils, which the doctor recognized as miocene. In the bowlders, scattered along the bed of Los Alisos Creek, we also found a variety of cretaceous fossils, and Dr. Cooper, in the course of his walk, found the same fossils in places some distance further up the creek. He did not ascertain the exact position of the cretaceous rocks at that locality, beyond the fact that they are unconformable with the miocene, which they underlie. The rocks in which these cretaceous fossils were found are a calcareous sandstone, dark blue in color, considerably metamorphosed, and quite hard. The previous evening, I noticed about one mile below Rawson's, on Los Alisos Creek, a locality where fossils were very plenty, and one good pecten was found here.

The cluster of the highest peaks of the Santa Ana Range lies near the line between Ranges 6 and 7 west of T. 5 S., S. B. M. The two highest ones differ but little in altitude, and constitute two of the most prominent land-

marks visible in this region from long distances in all directions, both at land and sea. The highest of these two peaks is the one which was ascended by Professor J. D. Whitney (then State Geologist of California) and party, on January 26, 1861, was found by them to be five thousand six hundred and seventy-five feet above the sea, and was then by them named Mount Downey, in honor of Hon. J. G. Downey, then Governor of the State of California.* Professor George Davidson, however, of the United States Coast and Geodetic Survey, informs me that this mountain has a much earlier claim to the name of Santiago Peak, by which it has been designated on some recent maps. I merely wish to note the fact that these two names have been applied to one and the same peak.

Now, Santiago Cañon, a branch of the Santa Ana River, heading about the western base of this cluster of highest peaks, follows a general northwesterly course for a distance of some fifteen or twenty miles to its junction with the Santa Ana River, a few miles northeast of the town of Santa Ana, and a short distance to the east, or a little south of east, from Anaheim. On the southwest side of this cañon, a long branch or spur of the Santa Ana Range, called Las Lomas de Santiago, runs northwesterly, gradually diminishing in height to within a short distance of the Santa Ana River, thus forming the northeastern boundary of all that part of the Anaheim Valley which lies southeast of the Santa Ana River. And these Lomas de Santiago, for a distance of at least five or six miles southeasterly from their northwestern terminus, consist entirely of unaltered tertiary sandstones and shales, which strike northwesterly and dip northeasterly at angles ranging from 20 degrees to 40 degrees.

The following information concerning early experiments with artesian wells in this region is given on the authority of Mr. W. H. Spurgeon, of Santa Ana; date, May 18, 1872:

About five miles up the Santiago Cañon he had sunk a well three hundred and fifty feet deep. At two hundred and eighty-seven feet he struck a small stream of water. At three hundred and fifty feet his sand pump got stuck in the well, and he never got it out. The water, however, rose to the surface of the ground, and he put a pump in the well and was getting some water from it. Southwest of Santa Ana, and southeast of the Santa Ana River, there were the following wells:

No. 1, forty feet deep	3-inch pipe.
No. 2, thirty feet deep	7-inch pipe.
No. 3, twenty-five feet deep	7-inch pipe.
No. 4, ninety-two feet deep	7-inch pipe.
No. 5, seventy-seven feet deep	7-inch pipe.
No. 6, one hundred and thirty-two feet deep	7-inch pipe.
No. 7, sixty-two feet deep	7-inch pipe.
No. 8, one hundred and forty feet deep	

Well No. 3 was flowing about sixty gallons per minute. Well No. 7 was yielding very little water. A well had also been sunk on the San Joaquin Ranch, at a point near the stage road about seven miles southeast of Santa Ana, two hundred and seventy-two feet deep, at which depth, no water having been obtained, the pipe stuck fast in the well, and it was abandoned. The first artesian well sunk in this vicinity, he says was sunk in 1870, at a point about one and one fourth miles northeast of Santa Ana; but no water being found at the depth of one hundred and two feet, the well was abandoned.

All these wells were entirely in the soft post-pliocene beds of the valley, no solid rock having been found in any of them. These beds consist of

* See Geology of California, Vol. I, Page 177.

alternating strata of sand, compact clay, and moderately coarse gravel. The nearer to the mountains the greater was the depth beneath the surface at which water was found. Two or three miles below Santa Ana the water comes to the surface of the ground. At Santa Ana the "surface water" is found at a depth of about ten feet, and three miles northeast of there it is sixty feet below the surface. The valley everywhere rises gently from the sea towards the mountains on the northeast, with a varying grade, which probably averages twenty-five or thirty feet to the mile. None of the above wells will lift their water more than a very few feet above the surface of the ground. There was said to be somewhere in the hills further up the Santiago Cañon, probably not far from the locality which has since been called Silverado, a bed of coal fourteen feet thick, which statement seems doubtful. I saw in Santa Ana some very impure specimens of "coal," which were said to have come from there.

In the Santiago Cañon there were in 1872 some of the finest groves of vine-clad oaks, wreathed with magnificent wild grapevines loaded at that time of the year with blossoms, that I have ever seen. There is also in the lower part of the cañon a great accumulation of gravel, forming for some distance a sort of mesa.

The old Spanish town of Santa Ana was located above the mouth of Santiago Cañon, at the end of the mountain spur between it and the Santa Ana River, about six miles east of Anaheim. From a point about seven or eight miles further up in the cañon of the Santa Ana River, and on the south side of it, a cañon runs up southerly into the mountains, leading to the first so called "coal locality" described under the head of "Other Coal Localities," on page 148 of the seventh annual report of the State Mineralogist. All the rocks seen in traveling up the south side of the river so far as this, are unaltered tertiary shales, conglomerates, and sandstones, dipping northerly at angles ranging from 10 to 30 degrees. A little to the west of this so called coal locality occurs a large mass of rock, which is chiefly made up of moderate sized oyster shells, poorly preserved, which led Dr. Cooper to judge the whole formation to be miocene.

About half a mile south of here, in the mountains, there is said to be a locality where gypsum or anhydrite occurs. This may possibly be the anhydrite locality referred to by Professor Dana in his "Descriptive Mineralogy," fifth edition, 1884, page 786. I fail to find that Professor Dana gives any locality of anhydrite "near Santa Maria River," as stated in the fourth annual report of the State Mineralogist, page 72; and this locality is certainly not very "near Anaheim," though it is near the Santa Ana River, as Dana states.

On May 24, 1872, ex-Governor J. G. Downey stated to the writer that he was the first one that obtained artesian water in Los Angeles Valley. The place where he got it was near the low hills north of Compton. The well was one hundred and twenty feet deep, and was still flowing a good stream of water. It was sunk in October or November, 1869.

A deposit of limestone among the low hills about a mile west of Los Alisos Station, and half a mile southwest of the railroad, has recently been quarried to some extent, and is said to make a very good quality of lime.

On May 25, 1888, a locality was visited at Turnbol Cañon, just back of the Greenleaf Hotel, at Whittier, where Mr. W. E. Youle was then drilling a well for oil. The rocks here strike about north 55 degrees east, magnetic, and dip about 40 degrees to the southeast. A little oil is visible here issuing from a stratum which crops for a little distance along the bed of the cañon. The well, when visited, was four hundred and sixty feet deep, the first two hundred feet being chiefly sandy shales, and the rest of the depth

in fine-grained sandstone to the bottom. The mouth of the well being about two hundred feet southeast of the outcrop of the oil-bearing stratum, and one hundred and thirty feet above it, the dip being 40 degrees, the well should have passed through this stratum at a depth of about three hundred feet, which it actually did, and a few barrels of heavy, greenish-black oil, of about 19 degrees Baumé, were pumped from it, but not enough to pay. They were then going deeper in the hope of striking another and richer oil-bearing stratum. At the same time, at another locality, about one mile east of here, Mr. B. Chandler was said to be engaged in taking out asphaltum and making preparations to drill for oil.

In September, 1874, the writer made a trip up the San Gabriel Cañon, some three or four miles above its mouth, and twenty-four or twenty-five miles from Los Angeles. The rocks here are all granitic. There is some auriferous gravel scattered about, high up on the spurs of this range, similar in its general character to that which forms the great hydraulic mines (now for some years utterly stopped by injunctions of the United States Courts) on the western flank of the Sierra Nevada, in the more central counties of the State. For further information as to the character and age of these gravels, see "Contributions to American Geology, Vol. I, from the Memoirs of the Museum of Comparative Zoölogy at Cambridge, Massachusetts, 1880; contents, the Auriferous Gravels of the State of California, by J. D. Whitney."

There is every reason to believe that these high and ancient auriferous gravels of the San Gabriel Range, and also the great mass of the whole range itself, from the Cajon Pass west, nearly or quite to the Los Angeles River, belong to the same geological ages, and derived their origin from the same causes as those of the western slope of the Sierra Nevada. The amount of denudation which has taken place since these ancient gravels were deposited has, of course, been something enormous—and no man can measure it.

One thing, however, is worth noting: To the west of the point where the Santa Ana River issues from the San Bernardino Range, the southern flanks of that range, so far west as the Cajon Pass, are not flanked on the south by any heavy body of unaltered tertiary strata, while the southern flanks of Mount San Bernardino itself, to the east of the Santa Ana River, bear very heavy masses of such strata, which rise very high against the mountain.

Again, from the Cajon Pass west, nearly to the Los Angeles River, the San Gabriel Range itself is not flanked on the south by any such accumulations of tertiary rocks.

These facts would seem to indicate, either that the date of upheaval of the great mass of the range from the Santa Ana River west to the Los Angeles River was somewhat earlier than that of the upheaval of Mount San Bernardino itself, or else that the amount of denudation which has taken place since the upheaval of these mountains has been vastly greater to the west of the Santa Ana River than it has been for a good many miles to the east of it. Which of these suppositions is true must be left for future explorers to find out.

In the Pacoima Cañon, on the northeastern side of the San Fernando Valley, some three and one half miles from San Fernando Station, and eight hundred to one thousand feet above the valley. Dr. J. S. Turner has a limestone quarry in the granite. The lower foothills of the mountains here are unaltered shales and sandstones, dipping northerly. The limestone itself, at the quarry, is highly crystalline. It seems to vary much in purity, containing in places considerable disseminated epidote, and being

also here and there irregularly and capriciously intermixed with granite. To produce a uniformly good quality of lime from this quarry will require a careful sorting of the rock. Yet, some of it seems to be very pure, and samples from the top of a freshly burned kiln slacked quickly and thoroughly, yielding, to all appearance, a beautiful quality of lime. There is no timber here, and the fuel used for burning the lime hitherto is sagebrush. The granite here also varies much in character. Some of it is very feldspathic, and contains very little mica; while some of it is full of black mica, and it contains much magnetic iron.

At a point about twelve miles west of San Fernando, Mr. Gilbert has a quarry of sandstone, which is being used to some extent for building purposes in Los Angeles. It is a medium-grained, light-colored, yellowish sandstone, of pretty uniform texture; but too soft to be a first class stone.

In a trip from San Fernando, up the valley of the Arroya de Las Palomas, to within about a mile of the San Fernando Railroad tunnel, all the rocks seen were unaltered sandstones and shales, the dip in the lower foothills being often 75 or 80 degrees to the north. But farther up, the rocks are in places greatly disturbed, and heavy bodies of them here dip to the southeast.

The new Mission Hotel, at San Fernando, stands about a mile southwest of the railroad station; and at about seven o'clock in the evening of May twenty-eighth it was suddenly invaded by a host of small, brown, flying beetles, with yellow legs, and yellow-edged wing-cases. They came in by thousands and tens of thousands, and filled all the lower story of the house during the whole evening, dropping all over the carpets, furniture, books, papers, and everything. They were about three eighths of an inch long, and narrow in form. Very few of them got up as high as the second story of the building, and the next morning they were all gone. On inquiring the next day at the railroad station, only a mile away, it was learned that none of them had been seen there. It must, therefore, have been a local swarm, covering no great area, though there were countless thousands of them; and they were traveling southwesterly, as they made their first appearance on the front porch of the building which faces the northeast. It was the first instance of the kind which the writer had ever seen, and reminded him of the local swarms of grasshoppers which are not uncommon in Central America. Don Benigno Pico, who lives at San Fernando, states, however, that he has often seen such swarms in Arizona, and he always considers them an immediate precursor of hot weather.

In a cañon on the northern slope of the range of mountains northeast of the San Fernando Railroad tunnel, and five or six miles southeast of Newhall, there are a number of localities of asphaltum, with more or less seepage of petroleum, in two different gulches; and in the eastern gulch, some four hundred or five hundred feet above the valley, a large accumulation of asphaltum extends for something like a quarter of a mile along the bed of the gulch. The seeping oil is black and heavy. The prevailing dip of the rocks here is northwesterly, though some of them dip south or southwest. They occasionally contain pectens and other shells. The bed of the gulch is strewn with granite bowlders from the mountains further east.

On the south side of this range, and a short distance southeast of the railroad tunnel, a small cañon, called Grapevine Cañon, runs southerly to the San Fernando Valley. At a point in this cañon well up towards the head of it, a well was drilled by Mr. Mentey in 1875 to a depth of four hundred and seventeen feet. A heavy deposit of asphaltum, with a very little seepage of heavy black maltha, extends for something like a quarter

of a mile up the cañon, above this well. The well developed some gas, and a considerable stream (probably five or six miner's inches) of water, containing a variety of soluble sulphates, but no oil. The quantity of gas is not large, being probably not one fifth so much as is yielded by either one of the Pico Cañon wells, Nos. 12 and 13. (See seventh annual report, pages 80, 81, 82.)

Some three or four miles southeast from here, and only about two miles northwest of Pacoima Cañon, are the limestone quarries of Mr. Wilson, who has been burning more or less lime here for a number of years. The limestone burned here is all crystalline, and a heavy body of it is inclosed in mica schist and gneissoid rocks. The latter are often curiously intermixed with the limestone itself in ways not easily explicable, the whole being very highly metamorphosed. No epidote nor graphite was seen here. Some limestone bowlders were seen that were filled with fossils, but they were not very well preserved, and it was impossible to get good specimens of them, the rock being too compact and hard.

MARIN COUNTY.

This county derives its name from Marin, a chief of the Sacatuit Indians, who originally inhabited this section of country. This word should be accented on the first syllable, and not on the last as is practiced by most people, under the supposition that it has a nautical meaning.

Marin County covers the peninsula lying between San Pablo Bay and the Pacific Ocean, its southern extremity forming Point Bonita, the outer north headland to the Golden Gate. The county is bounded on the north and northwest by Sonoma, on the east by San Pablo Bay, on the south by the Golden Gate and the Pacific Ocean, and on the southwest and west by the Pacific Ocean.

The surface of this county is rugged, consisting of hills and mountains, through which are scattered many small, fertile valleys. Mount Tamalpais, the outer ridge of the Coast Range, culminates in the western part of the county at an altitude of two thousand six hundred feet. The only timber growth here, except a few redwoods on the mountains, consists of white oak, scrub pine, and madrona, of which there is a good deal scattered over the hills and valleys.

BEACH SAND.

On the ocean side of Tomales Point occurs a deposit of auriferous black sand. It can be reached only at low tide and has not proved rich enough to warrant continuous working. Besides, the supply is uncertain, being dependent on the winds, the surf, and the tides. A little to the east of Tomales some locations have been made on a quartz ledge carrying gold. On the westerly slope of Tamalpais some silver prospects have been found but the find has not been followed up by any developments. In the vicinity of Tomales, cinnabar, manganese, and sesquioxide of iron have been found in small quantities, but no attempts have been made to do anything with them. In the vicinity of Porters Point, west side of Tomales Bay, there is a deposit of chromic ore, and garnets are also found.

Good building stone is found in this county, also clay, suitable for brickmaking. At San Quentin there are manufactured from clay obtained on prison ground one million five hundred thousand common, and eighty thousand pressed brick, annually. Many brick are also burned at different points on the shore of San Pablo Bay.

MARIPOSA COUNTY.

The name of this county (Spanish for butterfly) has, in its various applications, undergone considerable transmission; having in the first instance been given to a stream, El Rio de la Mariposa, next to a large land grant in the neighborhood, and finally to the county itself; and yet in all these applications the term, so far as regards any special significance, would appear to have been fanciful and meaningless.

This county, which is triangular in form, coming to a point on the east, is bounded on the north by Tuolumne, on the southeast and south by Fresno, and on the southwest and west by Merced County. Originally Mariposa included within its boundaries one sixth of the State. Through the creation of several neighboring counties out of its original territory this county has been reduced to about one thousand five hundred and forty-three and seventy-five one hundredths square miles.

The eastern half of Mariposa is mountainous; this part of the county reaching nearly to the summit of the Sierra Nevada. The foothills, as they extend toward the west, subside into the great San Joaquin plains. On the Merced River, in the northeastern part of the county, is the Yosemite Valley, one of the deepest and most abrupt depressions probably on the face of the earth. Another of Mariposa's natural curiosities is the Big Tree Grove; this, as regards number, being the largest collection of these giants of the forest in the State. The upper part of this county is heavily timbered, the lower part sparsely, there being no natural tree growth toward its western border. The Merced, a large river flowing west, traverses the whole length of the county. Mariposa and Chowchilla are small streams, the latter separating this from Fresno County, and both nearly drying up in the summer. There are no lakes in the county, unless Tenaya, a small pond in its northeastern part, may be called such.

MINES AND MINING.

Gold mining has from the first been in this county its most prominent industry. The placer diggings though not so extensive as in some other parts of the State, being rich and shallow and therefore easily worked, paid large wages in pioneer times. These surface deposits becoming speedily depleted, early recourse was had here to quartz mining, this industry having been inaugurated on the Fremont estate in 1851. In Mariposa that remarkable auriferous belt known as the mother lode of California has its southerly beginning, it being here displayed in great power. This lode, which strikes nearly north and south, dips to the eastward at an angle varying from 45 degrees to 70 degrees. The walls are uniform; the eastern hanging-wall is greenstone and the western foot-wall is slate. It is to be regretted that the mines belonging to the Fremont estate are not being worked at present, as they have not been for many years past, covering as they do a large portion of the mineral section of the county. This inaction on the part of the owners of the estate has had a depressing effect on the general business of the county.

QUARTZ MINING.

THE HITE MINE.

This mine is located in the Mariposa District, near Hites Cove, at an elevation of two thousand and eighty feet above the sea. The course of the vein is east and west, with a northerly dip of 75 degrees, and an average width of eight feet. The formation of both hanging and foot-walls is slate. Dimensions of the claim, three thousand feet in length by six hundred feet in breadth. The mine is worked through two tunnels, the upper one being seven hundred feet in length, and the lower one (which taps the vein nine hundred feet on the incline), below the upper one, is one thousand four hundred feet. From the point where the lower tunnel taps the vein, an incline shaft has been sunk three hundred feet in depth. Levels, run from either side of this incline, disclose a large body of ore. An engine run by compressed air is used for hoisting the ore to the tunnel, whence it is transported in cars to the surface, and carried by tramway to the ore house adjoining the company's mill.

The improvements here consist of a forty-stamp mill, a pan mill, and an air compressor, all run by water power. The stamps weigh seven hundred and fifty to eight hundred pounds each, fall from five to eight inches, eighty drops per minute, and crush one and three eighths tons per day to each stamp. The plates used are an apron, four feet wide and six feet long, connecting with a sluice twenty inches in width by fourteen feet in length. The apron has an inclination of one and one fourth inches to the foot; the sluice one inch to the foot. The water used here is conveyed to the mill through a ditch one mile in length, furnishing a forty-six-foot head, which drives a forty-eight-inch Leffel turbine wheel, giving the power necessary for running the forty-stamp mill. This water, after leaving the mill, is picked up and conveyed by flume and ditch, and applied to a twenty-four-inch Leffel turbine wheel, under a thirty-foot head, furnishing power to run the pan mill and the air compressor, located about one mile from the mine. The air is forced through three-inch iron pipe to the hoisting engine, located five miles from the mine. This company has a steam sawmill, with a daily capacity of six thousand feet of lumber.

There is no separate account kept of the difference between the battery and plate savings, merely a record of the general clean-up. The sulphurets (iron pyrites, zinc blende, and galena), assay value, $80 per ton, are allowed to escape, no provision having been made for saving them. The ore contains about 2 per cent of sulphurets, for the saving of which the company intend soon to put in concentrators. Formerly, when Mr. Hite, the discoverer, owned and worked the mine, the tailings were taken by car to the pan mill below, and some of them worked over, but with what results could not be learned. There is a large accumulation of these tailings, the pan mill not being run at present.

Altitude	2,080 feet.
Length of ore shoot	800 feet.
Length of ore shaft on incline	1,200 feet.
Depth of ore shaft vertically	200 feet.
Vertical depth reached in mine	900 feet.
Vertical depth of water shaft	200 feet.
Quantity of water raised in twenty-four hours	7,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Hercules, No. 1.
Quantity of powder used	20 pounds per day.
Cost of mining	$2 per ton.

Cost of tunnel	$8 per foot.
Cost of shaft	$8 per foot.
Number of feet timbered	1,500
Kind of timber	Pine.
Cost of timber	$15 per thousand.
Length of road built	6 miles.
Length of ditch built	2 miles.
Character of ore	Free milling.
Character of works	Stamp and pan mill.
Number of stamps	40
Weight of stamps	750 to 900 pounds.
Drop of stamps	5 to 7 inches.
Drops	80 per minute.
Duty of stamp	1⅜ tons in twenty-four hours.
Kind of shoes and dies	Chrome steel.
Size and character of screens	Slot, No. 40.
Water used in battery	1½ inches for each battery.
Dimensions of apron	4 by 6 feet.
Width of sluice	20 inches.
Length of sluice	14 feet.
Kind of feeder	Stamford.
Kind of pans	Varney & Wheeler.
Number of pans	4
Percentage of gold saved in battery (estimated)	80
Percentage of gold saved on plates (estimated)	20
Percentage of sulphurets	2
Value of sulphurets	$80 per ton.
Cost of milling	25 cents per ton.
Number of men in mill	5
Number of men in mine	22
Total number employed	31
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$1 75 per day.
Quantity of water used in milling	12 inches.
Head of water used for power	500 inches.
Fall of water used for power	46 feet.

RED CLOUD MINE.

This mine is located in the Coulterville Mining District, about nine miles easterly from the town of Coulterville, at an altitude of two thousand seven hundred feet above sea level. The vein is about three and one half feet in width, has an east and west course, and dips 20 degrees to the north. The mine is worked through a shaft on the incline five hundred and sixty-five feet in depth, reaching a perpendicular depth in the mine of four hundred and seventy-five feet. Both the foot and hanging-walls are slate. The dimensions of the claim are four thousand five hundred by six hundred feet. The developments here consist of an incline shaft five hundred and sixty-five feet in depth, with levels from one hundred and fifty to five hundred feet in length run at each one hundred feet in depth. The improvements are a twenty-two-stamp mill and hoisting works run by steam power. Each stamp weighs eight hundred pounds, falls from six to eight inches, at the rate of ninety times per minute, crushing one and one half tons per diem. The plates are silvered; the apron is four feet wide by five feet long; the sluice forty-seven inches wide by eleven feet long, with an inclination of one and one half inches in fourteen inches. Seventy-five per cent of the gold yield is recovered in the batteries and 25 per cent on the outside plates.

Altitude	2,700 feet.
Length of five ore shoots	Each 40 feet.
Length of ore shaft on incline	565 feet.
Vertical depth reached in mine	475 feet.
Vertical depth of water shaft	475 feet.
Quantity of water raised in twenty-four hours	5,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.

Kind of powder used	Hercules, No. 2.
Quantity of powder used	300 pounds per month.
Cost of mining	$2 25 per ton.
Cost of shaft	$25 per foot.
Number of feet timbered	565
Kind of timber	Pine.
Cost of timber	2 cents per running foot.
Length of ditch built	1¾ miles.
Character of ore	Free milling.
Character of works	Stamp mill and hoisting works.
Number of stamps	22
Weight of stamps	800 pounds each.
Drop of stamps	6 to 8 inches.
Drops	90 per minute.
Duty of stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	Pittsburg steel.
Size and character of screens	Brass wire, mesh 40.
Water used in battery	1 miner's inch to each battery.
Dimensions of apron	4 by 6 feet.
Width of sluice	47 inches.
Length of sluice	11 feet.
Kind of feeder	Challenge.
Kind of concentrators	Blankets.
Percentage of gold saved in battery	75
Percentage of gold saved on plates	25
Percentage of sulphurets	2½
Value of sulphurets	$100 to $200 per ton.
Cost of milling	60 cents per ton.
Number of men in mill	4
Number of men in mine	15
Total number employed	23
Average wages in mine	$3 per day.
Average wages in mill	$3 25 per day.
Average wages paid outside work	$2 per day.
Wood used	4½ cords per day.
Cost of wood	$3 per cord.
Quantity of water used in milling	4 inches.

MARY HARRISON MINE.

This mine is located a short distance east from the town of Coulterville, at an altitude of one thousand seven hundred feet above sea level. The course of the vein is northwest and southeast, with an easterly dip of 50 degrees. Average width, twelve feet; dimensions of claim, two thousand six hundred feet by six hundred feet. The property was owned and worked by a French company about fifteen years ago, in which F. L. A. Pioche was the principal owner. This mine is opened by an incline shaft six hundred feet in depth, and several levels run northward from one hundred to three hundred feet in length. Several thousand tons of ore have been extracted here and milled with good results, a large amount of the ore yielding $60 per ton; the lower grade averaging from $10 to $12 per ton. The fissure is very large, probably three hundred feet in width, containing different veins of quartz, all carrying gold. Only one vein, however, has been worked, and in three hundred feet the end of the pay shoot has not yet been reached. This mine belongs to what is known as the Mary Harrison series, located on the mother lode, one half mile east of the Malvina series, and parallel thereto. There are in the Mary Harrison series: The Mary Harrison, the Dahlia, the Venture, the Louise, the Margaret, and Black Hill. Of this group of claims the Mary Harrison is the most prominent.

Altitude	1,700 feet.
Length of ore shoot	400 feet.
Vertical depth reached in mine	300 feet.
Vertical depth of water shaft	300 feet.
Character of hanging-wall	Porphyry and greenstone.
Character of foot-wall	Slate.

Kind of powder used	Giant, Nos. 1 and 2
Cost of mining	$1 50 per ton.
Cost of shaft	$10 per foot.
Number of feet timbered	600
Kind of timber	Pine.
Cost of timber	10 to 14 cents per running foot.
Length of road built	1 mile.
Cost of transport of ore	50 cents per ton.
Character of ore	Free milling.
Percentage of sulphurets	1

THE MELVINA GROUP OF MINES.

This group of mining claims is located near the town of Coulterville, at an altitude of one thousand seven hundred feet. The Melvina No. 1 is one of a series of mines situated on a lode one half mile west of the Mary Harrison group, and parallel thereto. It was located in 1852, and the course and dip are the same as the Mary Harrison. Melvina No. 1, the most prominent of this group, is opened by a tunnel one thousand two hundred feet long, reaching a vertical depth from the surface of four hundred feet. This tunnel has opened up one pay shoot four hundred feet in length, from which three thousand tons of ore were extracted and milled, yielding an average of $7 per ton. The average width of this vein is ten feet. This series comprises the Melvina No. 1, the Melvina No. 2, the Potosi, the D. Cook, the Douglass, and the Mahone, all of which have been more or less developed. Water can be obtained for milling purposes. None of these mines are being worked at present.

Altitude	1,700 feet.
Length of ore shoot	400 feet.
Vertical depth reached in mine	400 feet.
Character of hanging-wall	Greenstone.
Character of foot-wall	Slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used	1 pound per foot run.
Cost of mining	50 cents per ton.
Cost of tunnel	$7 per foot.
Kind of timber	Pine.
Cost of timber	8 to 10 cents per running foot.
Character of ore	Free milling.

HATHAWAY BONDURANT MINE.

This mine is situated at an altitude of two thousand eight hundred and sixty feet above sea level, in Coulterville Mining District, and distant from the town of Coulterville, in an easterly direction, about eleven miles. The dimensions of the claim are: One claim one thousand five hundred feet in length by three hundred feet in width, and an extension one thousand five hundred feet in length by six hundred feet in width. The course of the vein is east and west, with a northerly dip of 38 degrees; average width, two and one half feet. The improvements here consist of a ten-stamp wet crushing steam mill; each stamp weighs seven hundred and fifty pounds, falls four to six and one half inches, at the rate of ninety-five times per minute, and crushes one and three fourths tons per diem. The aprons are five feet wide and eight feet long, and have an inclination of one inch in twelve. The sulphurets, of which the ore contains 5 per cent, are iron pyrites and galena. They have a value of $75 per ton, and are saved by a Frue concentrator.

Altitude	2,860 feet.
Length of ore shoot	250 feet.
Length of ore shaft on incline	92 feet.
Depth of ore shaft vertically	70 feet.

Vertical depth reached in mine	140 feet.
Vertical depth of water shaft	70 feet.
Quantity of water raised in twenty-four hours	2,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Hercules.
Quantity of powder used	250 pounds per month.
Cost of mining	$3 per ton.
Cost of tunnel	$6 per running foot.
Cost of shaft	$12 per running foot.
Kind of timber	Pine.
Cost of timber	2 cents per running foot.
Length of road built	2½ miles.
Cost of transport of ore	5 cents per ton.
Character of ore	Free milling.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamps	4 and 6½ inches.
Drops	95 per minute.
Duty of stamps	1⅗ tons in twenty-four-hours.
Kind of shoes and dies	Iron.
Size and character of screens	Slot, No. 10.
Water used in battery (to each battery)	1½ inches.
Dimensions of apron	5 by 8 feet.
Kind of feeder	Challenge.
Kind of concentrators	Frue.
Percentage of gold saved in battery	50
Percentage of gold saved on plates	50
Percentage of sulphurets	5
Value of sulphurets	$75 per ton.
Number of men in mill	3
Number of men in mine	9
Total number employed	15
Average wages in mine	$3 per day.
Average wages in mill	$3 25 per day.
Average wages paid outside work	$1 75 per day.
Wood used	4 cords per day.
Cost of wood	$3 25 per cord.

THE CRANBERRY MINE.

This mine is situated in Mariposa District, about four miles northerly from the town of Hites Cove, and to the north of the Merced River, at an altitude of two thousand five hundred and fifty feet above sea level. The formation is granite, the course of the vein northwest and southeast, with a northerly dip of 40 degrees; average width, two and one half feet. Dimensions of the claim, two thousand seven hundred by six hundred feet. The improvements here are two arrastras run by water power, and having a capacity of one ton per day each. The ore is free milling to a depth of one hundred feet; the gold below this depth is in the sulphurets, of which the ore contains 25 per cent; assay value, $30 to $40 per ton; none of the sulphurets have been worked.

Altitude	2,550 feet.
Length of ore shoot	400 feet.
Vertical depth reached in mine	320 feet.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Kind of powder used	Giant, No. 2.
Quantity of powder used	150 pounds per month.
Cost of mining	$4 per ton.
Cost of tunnel	$6 per foot.
Cost of shaft	$7 per foot.
Number of feet timbered	62
Kind of timber	Pine.
Cost of timber	4 cents per running foot.
Length of road built	1 mile.
Length of ditch built	1 mile.
Cost of transport of ore	$1 75 per ton.

Character of ore	Free milling.
Character of works	2 arrastras.
Percentage of sulphurets	25
Value of sulphurets	$30 to $40 per ton.
Cost of milling	$5 per ton.
Number of men in mill	1
Number of men in mine	6
Total number employed	9
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$1 75 per day.
Head of water used for power	200 miner's inches.
Fall of water used for power	18 feet.

MENDOCINO COUNTY.

This county is bounded by Humboldt, Trinity, and Tehama Counties on the north, by Lake and Sonoma on the south, and by the Pacific Ocean on the west. Two parallel chains of the Coast Range strike across this county north and south, and, lying between them, are a succession of long and fertile valleys. Through these valleys flow Eel River towards the north, and Russian River towards the south. They are the largest streams in the county. There are, however, other rivers of importance, some tributary to Eel as well as to Russian River, and some that hold their own course till in the Pacific Ocean. Mendocino is, in fact, one of the best watered coast counties in the State, as more than fifty large streams take their rise in the mountain chains mentioned.

In the matter of timber, Mendocino is the banner county of California. The outer Coast Range, with some level land between it and the ocean, running the whole length of the county, is covered for its entire extent with an almost continuous forest of redwood and pine, the trees of large size, and convertible into lumber of most excellent quality. This forest belt varies in width from ten to thirty miles, the average width being somewhat over fifteen miles.

Besides the wealth of timber, Mendocino boasts good agricultural and grazing resources. Mendocino is also one of the great hop raising counties of the State, rivaling, in this respect, the Puyallup country in Washington Territory. Hops grown in this county are known for the size of the flower and fine quality.

Mendocino has gained no distinction as a mining county, yet mineral resources are not wanting within her boundaries. Both lode and placer auriferous deposits have been discovered here at different times and in various places. A few of these deposits have been worked in a limited way. Copper ore, some of it promising, has been found in Coyote, Potter, and Walker Valleys. Exudation of petroleum has also been noticed in several parts of the county. At Punta Arenas this substance trickles from a sandy shale on the seashore. During the oil excitement in California in 1865 quite a sum of money was expended at this place to obtain a more ample supply from the shale, but without success. Sulphur and salt are met with in quantity, and mineral springs, hot and cold, issue from the earth. Among these is a fountain of natural soda water.

MERCED COUNTY.

This county derives its name from the Merced, a large river flowing across its northern half. The term, which in Spanish signifies mercy, was applied to this stream by the early explorers of the San Joaquin Valley, in honor of "Nuestra Señora de Merced."

This county is bounded on the northwest by Stanislaus, on the northeast by Mariposa, on the southeast by Fresno, and on the southwest by San Benito and Santa Clara Counties.

With the exception of an elevated strip lying along the eastern slope of the Coast Range, and a few oaks growing along the watercourses, Merced is a mountainless, and almost a treeless region; the rest of the county is in fact nearly a dead level. Besides the Merced flowing westerly across its northern border, the San Joaquin, a still larger river, flows north through the center of the county; tributaries to the latter, all coming in from the east, are Burns, Beans, Deadman, and Cottonwood Creeks, with the Mariposa and Chowchilla Rivers; but the most of these streams nearly or quite dry up in the summer. There are no large towns in this county, Merced City, the most considerable, containing only about three thousand inhabitants.

Although Merced is one of the foremost grain, wool, and fruit growing counties in the State, it is not entirely destitute of mineral wealth. There was at one time in the northeastern corner of the county a limited extent of placer diggings, and both quicksilver and antimony are found in the eastern portion of the McLeoud Mining District, which extends from San Benito into the southwestern corner of Merced County. Quicksilver is both mined and reduced in that district.

This portion of the McLeoud Mining District includes and lies to the south of the Mariposa Peak. The mines now worked are upon the eastern and southeastern slope of the Antimony Mountains.

A similar formation doubtless exists throughout an extended area in that portion of the county, which is at present in the hands of stockmen. The mines now in active operation are the Red Metal Mine, the Cincinnati, and the Woody Mines. The two last named mines, together with some small reduction works, are the property of the Gipsy Mining Company.

THE RED METAL MINE.

This mine is situated in Sec. 32, T. 11 S., R. 7 E., M. D. M., at the base of the peak called Crown Point. The croppings of quartzose rock showed both antimony and cinnabar. At the depth of about ten feet, a light-colored clay was struck, forming a foot-wall. This contained nodules of antimony. The ledge here pitches into the hill at an angle of about 12 degrees for about thirty feet; the angle then increases, and three feet further on to the magnetic north northwest, the working is in the solid ledge. There is no hanging-wall in sight. The ore possesses a quartzose gangue, and the richest cinnabar is found in seams and pockets running through the ledge. This mine has yielded sufficient cinnabar to amply repay for all the labor. The ore has been reduced at the works of the Gipsy Mining Company, upon the neighboring claim.

THE CINCINNATI MINE.

This mine belongs to the Gipsy Mining Company, and is situated in Sec. 5, T. 12 S., R. 7 E., M. D. M. It consists of an upper and lower level. The

lower level commences with a tunnel running into the mountain, towards the magnetic southwest, through a slate formation for a distance of about one hundred and ten feet. A light-colored clay (caleche) was then encountered, five feet in thickness; this was occasionally mixed with slate in knots and bunches, and acted as a foot-wall to a body of quartzose rock, containing streaks and pockets of cinnabar. An incline of fifty feet was here sunk upon the vein, and crosscuts of about one hundred and fifty feet, both to to the magnetic east and west, made upon it. No hanging-wall has yet been found. Wm. Woody says that this hard quartzose rock has yielded on an average about 2½ per cent quicksilver. About forty-five feet from the north end of the crosscut the vein changes from a hard siliceous rock into a conglomerate, which has been followed by sinking a winze about twenty feet deep. At the bottom of the winze the vein has been cut into for a depth of about four and one half feet, without discovering any head-wall. The foot-wall dips to the magnetic south southwest at an angle of about 55 degrees. Mr. Woody says that this conglomerate has averaged 3 per cent quicksilver, and that this estimate was derived from carefully noting the amount of quicksilver obtained by actual furnace assay of two hundred pounds of unsorted ore. He states that by sorting it can be made to assay 20 per cent. About $40,000 worth of quicksilver has been taken out from this lower level, the ore being reduced on the premises. The upper level is about ten or twelve feet above the lower; it consists of a series of tunnels and drifts, from which, it is stated, $25,000 or $30,000 worth of quicksilver has been taken out, all of which has been reduced in this district. This mine was worked during 1870 and 1871 by the Stayton Mining Company.

THE WOODY MINE.

This mine also belongs to the Gipsy Mining Company, and is situated in Sec. 5, T. 11 S., R. 7 E., M. D. M. It consists of a tunnel running in an easterly direction into a hill at the base of Antimony Mountain, locally known as Gipsy Peak. This tunnel was through a slate formation for about one hundred feet. Here a vein six feet wide was encountered, pitching to the west at an angle of 70 degrees. The vein itself is for the most part a quartzose rock, containing seams and pockets of ochre and cinnabar; both walls are slate. A winze has been sunk upon the vein to a depth of about thirty-five feet. At the top of the winze is a hard, white clay, which further down becomes incorporated into the vein. In this winze a pocket was encountered, from which three hundred pounds of ore were taken out. This was retorted by itself as an experiment, and yielded ninety-one pounds of quicksilver. This mine was located in June, 1885.

REDUCTION WORKS.

Quicksilver was first reduced in this district by R. Stayton. The first works were put up in 1881 by R. Griffin, who then owned the Cincinnati Mine, which he subsequently sold, together with the works, to the parties now in possession. The ore is now reduced by the Gipsy Mining Company in two retorts, the capacity of each being one thousand two hundred pounds in twenty-four hours. Each retort is charged every eight hours with four hundred pounds of ore. The assorted conglomerate yields about 3 per cent of quicksilver, the assorted quartzose ore 6 per cent. The average cost of mining is about $2 per ton, delivered at the retort house.

MODOC COUNTY.

This county is named after an Indian tribe that formerly ranged in the northeastern part of California. It is bounded on the north by Oregon, on the east by Nevada, on the south by Lassen and Shasta Counties, and on the west by Siskiyou County.

Modoc may be considered a high sage plateau, the plains broken by low ranges of mountains, the general elevation being over four thousand feet above sea level. The more elevated mountain range, the Warner, strikes north and south across the eastern border.

There are numerous lakes, which, though covering a large area, are, for the most part, shallow. Pitt River is the only large stream within the county limits. It has its origin in Goose Lake, on the northern border. A portion of this lake lies in the State of Oregon. Issuing from its source, the Pitt flows in a southwesterly direction centrally across the county.

Excepting on the slopes of the Warner Range, before mentioned, where grow heavy forests of pine and cedar, there is but little timber in Modoc. The plateau is covered with a variety of wild grasses, which afford good pasturage, and the stock subsisting thereon are generally in fine condition. In the valleys good farming land is found. Surprise Valley is the largest in extent, and is noted for the richness of its soil.

Mineral springs abound everywhere, for the waters of which medicinal virtues are claimed.

The principal towns in the county are: Alturas, the county seat; Fort Bidwell, a military post; Cedarville and Adin, the principal mining center; and Eagleville.

While Modoc may and, no doubt, does contain mineral deposits of many kinds and of much importance, none of ascertained value has yet been discovered. Many years ago a number of silver-bearing lodes were located in the mountains, near Surprise Valley, and some prospecting work done. On one of the locations a quartz mill was erected, but owing to the remoteness of the place, and, in some measure, to Indian hostilities, the work of development was tardy, and, when the mill was destroyed by fire, finally abandoned. The amount of bullion obtained from the working was inconsiderable, so the extent and value of existing deposits are left, as yet, undetermined. The settlers in the county have turned their attention chiefly to farming and stock raising; mining is nearly altogether neglected. In Lassen County, just over the southern boundary of Modoc, quartz mines are being worked. (For further description see Lassen County.) Modoc's mineral wealth is yet lying dormant, awaiting the awakening hour of enterprise.

MONO COUNTY.

By H. A. Whiting, E.M., Assistant in the Field.

The material for the following report upon the mining districts of Mono County was gathered in a necessarily rapid reconnaissance made in the latter half of August and the first part of September last. To cover so wide a field in that time and under the limitations imposed by the conditions of travel in a remote, mountainous, and thinly populated region, restricted the field work to such observation of the prevailing geological conditions as could be gained in an all too hurried examination of a small portion only

of each mining district, and as rapid and unsatisfactory an inspection of the underground workings in but one, or at the most, two of its mines. The Bodie District is to be excepted, however, respecting which the writer had the advantage of information gained in a residence of several years there.

Inasmuch as all of the rock determinations herein given were made from hand specimens—with the exception of that of the Bodie rocks—they are necessarily subject to uncertainty and are here only provisionally offered until proper microscopic determinations can be made. In the brief time at command there was no opportunity for the preparation of thin sections of these Mono County igneous rocks from the specimens of them sent to the Mining Bureau. The source of information respecting the Bodie andesites is duly acknowledged in its place in the report.

Mono County is bounded on the north and east by the State of Nevada, on the south by Inyo County, and on the southwest and west by Fresno, Tuolumne, and Alpine Counties. Its western boundary is very tortuous, following, as it does, the bold and jagged granitic crest of the Sierra Nevada; but the average trend is about south 25 degrees east. The eastern boundary runs south 50 degrees east, nearly, along the State line between California and Nevada. In shape this county is rudely triangular, having the apex of the triangle about eleven miles northwest of Coleville, and for a base the east-west line separating it from Inyo County on the south. The extreme length along the line joining its apex and center of its base is about one hundred and ten miles; the breadth along its southern boundary is about fifty-two miles. The area is stated to be two thousand one hundred and ninety-seven square miles*, containing one million, seven hundred and ninety thousand acres†. Its population, which in 1870 was given at four hundred and thirty‡, is at present estimated to be from one thousand two hundred to one thousand five hundred. In 1879 to 1880, however, there are reported to have been no less than eight thousand people living in and immediately about the town of Bodie alone.

The area covered by this county forms a portion of the Great Basin which stretches between the Sierra Nevada and the Rocky Mountains. In its larger features, therefore, Mono County is a broad table land ranging from five thousand five hundred to seven thousand feet above sea level, and having an average altitude of about six thousand five hundred feet. The High Sierra forms the western boundary of this elevated plateau, rising in its majestic crests and peaks to altitudes of from twelve thousand to fourteen thousand feet. That portion of the county which lies along the eastern base of the Sierra Nevada forms the thrown side of the Sierra Nevada fault, and is thus walled in by the lofty mural cliffs determined by that profound displacement. These rugged scarps are often most highly colored, giving by the rich depth and variety of their tone, a marvellous charm to the grand scenery in which they are framed.

A series of approximately parallel ranges running northerly and southerly, rib, as it were, the Great Basin plateau, and rise in their higher members from four thousand to seven thousand feet above its plain. These ranges have been determined by those grand displacements which characterize the Great Basin structure as it has been described by King, Gilbert, and others. They are, therefore, like the Sierra Nevada itself, "orographic blocks bounded by faults and so tilted that their upturned edges form mountain crests with a steep descent on one side and a more gentle slope

* McCarthy's Statistician.
† Ibid.
‡ The American Encyclopedia, ed. 1875, article, Mono, p. 755.

in the opposite direction."* Among such ranges, in Mono County, two grand mountain masses are preëminent, rivalling the Sierra Nevada in height and majesty; they are the Sweetwater Mountains, along the eastern border of the county in its northern portion; and the White Mountains, crossing its extreme southeast corner and known further south as the Inyo Range. These two ranges are said to rise to the height of something over twelve thousand and thirteen thousand feet, respectively, above sea level.

In the High Sierra, upon Mount Conness, Mount Dana, Mount Gibbs, and elsewhere within the limits of this county, Mr. Russell reports that "nine glaciers now exist within the southern rim of Mono Lake drainage basin, and have an approximate elevation of eleven thousand five hundred feet above the sea."† These, with a somewhat larger number found on Mount Lyall, Mount McClure, Mount Ritter, and other neighboring peaks which dominate this region, are the remains of "glaciers of large size which formerly flowed down from the high Sierra * * * and deposited moraines of great magnitude, on which the terraces of the quaternary lake that formerly filled the (Mono) basin to the depth of nearly nine hundred feet, are distinctly traced."‡

Of this great inland sea of quaternary time, Mono Lake is the modern representative, and is the only large body of water in Mono County. It lies somewhat to the north and west of the center of the county, about ten miles due south from the town of Bodie, and at an altitude of six thousand seven hundred and thirty feet§ above sea level. Its length from east to west is reported to be fourteen miles, and its breadth from north to south about nine miles. "This lake is a strong solution of the carbonate and the sulphate of soda, chloride of sodium, etc., while many of the springs that rise in it are quite remarkable for their purity, but yet contain a small percentage of calcium carbonate, which is deposited about their points of discharge. These accumulations frequently form domes of large size that are porous and tubular in structure. * * *

"In numerous instances the deposits from the springs in Mono Lake form irregular tubes that are clustered together, and frequently branch and expand as they grow upwards, thus forming columnar and vase-shaped structures. The tops of some of these structures are occupied by basin-shaped depressions, which, in a few instances, are filled with water that rises through the irregular tubes and open space in the column beneath. The water in those basins is cool and fresh, and, overflowing fountain-like down the sides of the vases, mingles with the waters of the lake. These structures are still growing by the gradual precipitation of calcium carbonate, which is taking place, however, only above the lake surface. They are nearly always considerably smaller at the lake surface than at the top, and in general form are not unlike the sponges known as Neptune's cups, found in the southern seas. They are not only striking examples of chemically formed rocks that are of interest to the geologist, but they are fountains of sweet water in the midst of a lake that is utterly unfit for drinking. In some instances tufa towers, ten or twelve feet in diameter, perhaps, occurring in clusters, rise twenty or thirty feet above the bottom where soundings show the water to be forty feet deep. * * * At times springs

*United States Geological Survey, Monograph XI, Geological History of Lake Lahontan, page 24.

†Fifth Annual Report, United States Geological Survey, page 25.

‡United States Geological Survey, Monograph XI, Geological History of Lake Lahontan, page 267.

§Determined by railroad levels.

rush upward from openings in the tops with such force that their presence is distinctly marked at the surface by a low dome of water."*

There are several islands in Mono Lake, two of them of considerable size, and all composed of volcanic material. At the southeast corner of the largest island, which is about two and one half miles long, from north to south, are hot springs and steam jets covering some thirty acres of land, and extending into the lake, the temperature of whose waters is thereby perceptibly increased for a distance of many rods from the shore. In one place is a large fissure, caused by the sinking in of a portion of the crust at a quite recent period, as evidenced by the bushes which grow on the sunken portion, and which are still to be seen among the material at the bottom of the fissure. From this cavity much steam and hot gases issue. On the northeastern part of the island are two well defined craters, now filled with water.

At the west end of the smaller of the two principal islands, which is about one half a mile long, from east to west, a volcanic cone is to be seen. This cone, about three hundred feet in height, is very rough and wholly destitute of vegetation. "It appears to be more recent than any cone in this State, unless it be those north of Lassen Peak." Myriads of aquatic fowl resort to this lake to breed, during the summer, but its waters are destitute of all life excepting a small fly, whose larva is a white worm thrown in immense quantities upon the shores of the lake. These larvæ, when dried, are used by the Indians in this region as an important article of food, under the name of *Koo-chah-bee.*†

The whole region for hundreds of square miles about Mono Lake abounds in evidences of great volcanic activity during tertiary and post-tertiary periods. The greater portion of the lake itself is thought to occupy what was once the crater of a great volcano; and stretching for several miles about south 20 degrees east from the lake, are a series of scoria-covered volcanic cones, which have been described by Mr. I. C. Russell‡ as follows: "The Mono craters form a range ten or twelve miles long, which extend southeastward from the southern shore of Mono Lake, and in two instances attain an elevation of nearly three thousand feet above the lake. A few coulées of dense, black obsidian have flowed from them; but the great mass of the cones is formed from the pumiceous obsidian which occurs both as lava flows and ejected fragments, the latter forming a light lapilli, which gives a gray color to the outer slopes of the craters. Fragmental material of the same nature has been widely scattered over the mountains and on the ancient moraines that occur in the Mono Basin; while fine dust, unquestionably derived from the same source, may be traced to still greater distances. * * * We conclude that the strata of fine, siliceous, dust-like material occurring in the Lahontan sections, as well as similar traces found about Mono Lake and scattered as superficial deposits over the neighboring mountains, are all accumulations of volcanic dust which was probably erupted from the Mono craters. The greatest distance from the supposed place of eruption at which these deposits have been observed, is about two hundred miles."

Over all the area of the Mono Basin, and of that portion of the Lahontan Basin lying in Mono County, the surface is covered with this pumice and

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*United States Geological Survey, Monograph XI, Geological History of Lake Lahontan, pages 221-2.

†The description of these islands is condensed from the Geological Survey of California, J. D. Whitney, State Geologist, Vol. I, Geology, pages 453-4.

‡United States Geological Survey, Monograph XI, Geological History of Lake Lahontan pp. 148-149.

pumiceous sand, lava, and flakes of obsidian; and everywhere, too, are there evidences of the thermal energy which succeeds to great volcanic activity. Hot springs, many of them in a state of active ebullition, are found in a number of localities in the county, depositing, in some instances, calcareous tufa, and in others a siliceous sinter, and from others of which rise acid and sulphurous vapors. About one mile southeast of Bridgeport, where the action of the thermal waters is seemingly in its last stages, veins of travertine, showing beautifully in places the banded structure, can be seen; in some of them a center space is still open, through which the heated currents once reached the surface along a series of northeasterly-southwesterly fault-fissures in andesitic (?) rocks. Only a few miles west and southwest from Bridgeport, in the cañons of the Sierra Nevada, are several other hot springs, whose waters flow more abundantly, and at a much higher temperature, it is reported, than those just described.

Not more than four or five miles, a little to the east of north from Bodie, the representative of what was probably a tertiary volcano, raises its graceful cone several hundred feet above the nearly level floor of a high and wide extended table land of basaltic rock, through which, at and below Sunshine, the Bodie Cañon has been formed, by what seems to have been a great east-west fault. About two miles west of this cone, and where the old road from Bodie to Bridgeport passes beneath an escarpment of this volcanic mesa, a deposit of native alum is forming in efflorescences and incrustations, upon a compact, hornstone-like rock, which is, perhaps, an altered slate, outcropping there above the basaltic overflow. Still further west, about one mile, is an occurrence of cinnabar in a vein of chalcedony. A short incline of twenty feet in length was sunk upon this vein nearly ten years ago, but no further work thereon has since been attempted. This vein is two feet wide, with an easterly strike, and a dip northward at an angle of 20 degrees. Its inclosing rock, which is very much altered into reddish-brown and greenish-yellow clays, is seen, where least decomposed, to be a compact andesitic (?) breccia, containing fragments of pumice and of several older andesites (?). The cinnabar occurs in veinlets and incrustations, and is often crystalline.

About ten miles eastward from Mammoth, in the southern portion of the county, are the Casa Diablo Hot Springs, a little to the north of the road to Benton, and at the foot of what appears to be a fault-escarpment at the base of a hill of some dark-colored, igneous rock. These springs were not visited; but a nodular specimen of siliceous sinter was shown as having come from there, and as characteristic of the deposits from this spring. Within two or three miles, a little northeast from Casa Diablo, in Hot Creek Cañon, is a group of small geysers, so called, whose steam, issuing with considerable force from fissures in the igneous rock forming the bed of the creek, heats its waters and gives name to the stream and cañon.

At Benton, also, are thermal springs whose waters, when cooled, are used for drinking purposes by the townspeople. The principal spring is nearly circular, and is about eighteen feet in diameter now, though said to have been considerably larger in the early history of the town, and to have filled up more or less in the course of years by sands and gravel washed into it. An odorless gas comes from its surface, but without great activity. Its temperature is thought to be slightly decreasing; though it was not ascertained that experiments had ever been made to determine that question. Mr. W. A. Goodyear, however, who visited and took the temperature of this spring on June 28, 1870, at 9 A. M., reports that it registered 135.5 degrees Fahrenheit on that occasion. The temperature, as taken by the writer on September 8, 1888, at 1:30 P. M., and three feet from the edge of the basin, was 57

degrees Centigrade (134.6 degrees Fahrenheit). So slight a seeming change in temperature, however, could readily be accounted for by the difference in readings between almost any two ordinary thermometers, and can hardly, therefore, be considered as evidence that any real change in the temperature of this spring had taken place in the intervening eighteen years. The flow from this spring was judged to be in the neighborhood of forty-five cubic feet per minute, possibly more; and its waters, which for many years have been used in steam boilers at Benton, are said to give no scale or deposit. To the skin this water imparts an agreeable softness and a slightly saponaceous feeling; to the taste there is just a suspicion of alkalinity, which by many, however, is not noticed.

Mono County has no rivers properly so called, but it has many large streams on its western border coming from the numerous cañons of the High Sierra and furnishing most excellent water power during the greater portion of each year.

The climate is somewhat rigorous in winter, and even in summer the nights are at times so cold that ice forms in August. Here and there throughout the county are narrow belts of alluvial land along its creeks, upon which a little agriculture is carried on. The largest of these is Big Meadows, at Bridgeport, from which a large amount of hay is cut each year. Saving along its western border in the eastern cañons of the High Sierra, the county is but scantily supplied with timber, and what there is consists generally of juniper and piñon pine, the latter making an excellent fuel for steam purposes. In the Sierra cañons, however, the timber is generally abundant, and grows to a large size. The varieties are tamarack, several species of pine, spruce, and, along its creeks, the cottonwood, a species of aspen.

The principal towns in this county are Bridgeport, its county seat; Bodie, the chief mining town; and Benton, in its southeastern portion. As an agricultural and grazing country the county takes a low rank, but its mineral production has been a large one. And though its mining industry is very much less active than it was formerly, its mineral resources are such as to challenge attention.

Profound dynamic disturbance and energetic igneous action at successive periods throughout Tertiary and post-Tertiary times have had an abundant play over this wide desert region, in which are found a great variety of eruptive rocks. It abounds, moreover, in numerous and not infrequently richly mineralized vein systems: and to the geologist and mining engineer the whole region is one that offers a most interesting and valuable field for the careful study of most of the dynamic and structural conditions that obtain in the genesis and distribution of ore deposits.

PATTERSON MINING DISTRICT.

This district lies directly north of Bridgeport, in the Sweetwater Mountains, whose southern slopes begin to rise from the Big Meadows plain only four or five miles north of the town. That noble mountain mass rises with great abruptness, on its eastern side, from the valley of the East Walker River, and forms, from that point of view, a most majestic feature in the landscape. Its several cañons on that side, some eight in all, are deeply eroded, and in several instances are so narrow as to form gorges. In nearly all of them are large mountain streams that could be utilized as valuable water powers during the greater portion of each year, by mills placed near their places of debouchment upon the East Walker Valley. The West Walker River, flowing northward, receives the drainage from the western,

and much less steeply inclined, slope of these mountains; and these two branches of the Walker River, both of which find their sources in the rugged cañons of the High Sierra, some fifteen miles or more to the west and southwest of Bridgeport, respectively, finally pour their united waters, after a long journey, into that one of the present representatives of the ancient Lake Lahontan, now known as Walker Lake, in Nevada. The average elevation of the Sweetwater Mountains, as said to be registered upon the Government monument on the top of the crest at the head of Sweetwater Cañon, is ten thousand nine hundred and eighty feet above sea level; but Mount Patterson, to the south of this monument, and at the head of Frying-pan Creek, is reported to have an altitude of something over twelve thousand feet, and several other peaks rise nearly as high.

This mining district, which was organized as such in the spring of 1880, extends northward from Bridgeport, some twenty miles, and embraces the whole of the Sweetwater Range: but the mineral locations are confined generally to that portion of its eastern flank lying between Frying-pan Cañon on the south, and Sweetwater Cañon on the north end of the range; and thus extend over an area of some six miles from south to north by about three miles from east to west. Very little mining has been done along the western slope, however, and no developments of importance have as yet been made there.

The town of Cameron, in Frying-pan Cañon, is twelve miles north of Bridgeport, or fifteen miles by road, and in what is known locally as the "gold belt" of the range. About three miles north of Cameron, in Ferris Cañon, is Clinton, the first town established in the district, and in what is called the "silver belt." This distinction respecting gold and silver belts will be referred to farther on. At present the only organized mining work going forward in the district is that which the Monte Cristo Mining Company is now doing upon its group of mines just west of Cameron. Besides this, however, a few miners are engaged in prospecting their claims in a small way.

In respect of timber and water supply, the district is much favored. Abundant forests are close at hand, and, as stated above, its several creeks carry large streams for eight or nine months in the year. Crosscut as its vein systems are, moreover, from east to west, by deeply eroded cañons, the greater number of the lodes could be advantageously exploited and drained by adit levels on them or by crosscut tunnels and drifts therefrom, and to depths of from five hundred to one thousand feet and more.

The veins in this district are found in a nearly white quartz porphyry (so far as the same could be determined from hand specimens), having a compact, felsitic ground mass, throughout which small granules and spicules of quartz can be seen. To the unaided eye the entire rock seems very compact, and has a somewhat porcelain-like appearance from an alteration of its feldspar. None of the mine workings have yet reached a depth at which this rock can be seen in its fresh condition. The porphyry weathers in somewhat conchoidal, sherd-like fragments with rounded edges, and from a quarter of an inch to two and three inches in thickness. These cover the greater part of the surface to a depth of several feet, so that in many instances the veins are without a distinct outcrop, but are traceable and have been located by float quartz mixed with the porphyry fragments, neither of which show evidence of transportation or of being other than the result of degradation in place of the vein and its inclosing rock. These weathered porphyry fragments, moreover, are often beautifully marked with narrow red and brown bands, due to the presence of iron oxides resulting from the oxidation of pyrite, which was doubtless dis-

seminated through the rock mass in very minute form; in some that were seen these bands were concentrically arranged.

Cutting through this porphyry terrane are a number of intrusive masses of other eruptive rocks with generally wide intervals of porphyry between them. In several instances observed, these intrusive masses appeared to be andesitic. Their contact with the porphyry is not traceable on the surface by reason of the accumulation of debris; nor has such contact been reached anywhere in the district by the mine workings, so far as could be ascertained. Near the head of Frying-pan Creek, however, in the M. & T. tunnel, west of a small lake and at an altitude of about ten thousand feet, a granite rich in epidote is meet with. Going a little further west and across the southwest slope of Mount Patterson in a direction a little north of east, occurs the wide outcrop of a greenish and purplish-tinted rock, compact in texture but very much altered and filled with calcite. Not far to the west of this place, the head of Frying-pan Cañon is walled in by a bold and steep escarpment of what seems to be a hornblende-porphyrite having a dark, greenish-gray, compact ground-mass beautifully porphyritic with long crystals of hornblende, which frequently cross one another. The specimen gathered was considerably weathered, and showed a distinct fissile structure, breaking readily into thin plates.

The lodes of the Patterson District, so far as developed, have in general a strike from north to about 25 degrees west of north; in which respect they seem to observe a certain parallelism with what appears to be the prevailing trend of the intrusive masses, or dikes as they may be found in some instances to be. To determine the structural relations of these ore deposits, and the character and cause of the rock movement or movements to which they owe their origin, would, of course, require a careful and extended study of the whole district and its environment; but that they are dynamically related to such intrusive masses suggests itself to one upon the ground. The lodes have been formed, apparently, by such movements as shattered the porphyry along certain parallel and generally well defined zones, which thus admitted the mineral solutions that in part filled the crevices thus created, in part replaced and impregnated the porphyry between the principal structural planes. The intrusive masses, though presenting considerable variety in habit and in mineral composition, seem to be prevailingly of an andesitic type, with such exceptions as were noticed hereinbefore; and they probably have an important development in depth. In several places where they were observed, these rocks were more or less mineralized by pyritic material, and are not improbably one source from which the fissured porphyry may have received the minerals which now fill its veins: certainly the heat of so great an eruptive mass, cooling slowly at great depths, would have rendered more potent the action of infiltrating waters.

The veinstone of these lodes, in the few instances observed, consisted principally of a compact white quartz and shattered porphyry whose numerous cracks had been healed, as it were, by the quartz, which was often chalcedonic in character. In places the quartz was not unlike hornstone; in others it was saccharoidal; very rarely it was crystalline. Calcite was found associated with the quartz in small quantities; and fluorspar is reported as a gangue occurrence in at least one of the veins—the Kentuck.

The ore minerals found in the lodes of the Patterson District are native gold, auriferous pyrites, argentite, kerargyrite, and, rarely, native silver; associated with which are magnetite and other iron oxides. These minerals are for the most part disseminated through the quartz in a minutely

crystalline or granular condition; the gold is seldom visible in the ore, and the silver minerals are usually in a state of such fine subdivision, and so intimately mingled with the quartz, as to present themselves merely as dark bluish spots therein. The best ore seems to lie in the veins in lenticular masses of moderate extent, which are separated from one another by greater or less intervals of a very low grade, but never wholly barren, quartz.

The average proportions between the silver and gold tenure in these ore bodies, while found to vary materially in different localities in the district, yet seem to observe a certain constancy of relation as between veins which lie within certain limits that are definable, in a broad way, and which, on a superficial examination at least, appear to be associated in groups in not less than three approximately parallel belts of porphyry. These porphyry belts are themselves separated by intrusive rock masses of varying habit and mineral composition, as before stated; and such coincidences are certainly most suggestive in explanation of the observed differences in the argentiferous and auriferous mineralization of the lodes.*

Those veins which lie just above Cameron, in the porphyry immediately west of a broadly developed andesitic mass traversing the lower flanks of the range in Frying-pan Cañon, constitute the gold-bearing lodes of the district. They carry only a subordinate value in silver, much of which appears to be alloyed with the native gold. In this locality, which for present purposes may be designated as the Cameron belt, are found many locations; but the principal developments have been made upon the mines of the Monte Cristo, Patterson, and Thoroughbrace groups. Such bullion as has been produced from these mines is reported to have had a value of from $6 to $13 per ounce. No developments have been made, according to information, upon what would be the extension of this group of veins, in any of the cañons lying north of Frying-pan; indeed, their trend would carry such lodes, if so far continuous, to the point at which the nearest cañon on the north, Green Creek, begins to debouch upon the valley of the East Walker River. In this eastern belt the veins have a strike west of north, and a dip eastward at high angles.

In the mines of what may be called the Clinton belt, the ore is argentiferous, and contains but little more than traces of gold. In this region, embracing a wide belt of porphyry lying west of a north-south line through the town of Clinton, and extending from Cottonwood Cañon on the north to the upper part of Frying-pan Cañon on the south, thus crossing Silverado, Ferris, and Green Creek Cañons, very many locations have been made. The principal mines in this belt are the Lady Hayes, Kentuck, Homestake, Poverty, and Silverado, of which number the Kentuck is the most developed property in the whole district. These lodes strike north to north 25 degrees west, and dip to the westward and southwestward at angles varying from 30 degrees to 55 degrees.

Still higher up, along the crest of the range where it crosses between the heads of Sweetwater and Ferris Cañons, and at an altitude of about ten thousand feet above the sea, lie the mines of what may be called the Comstock belt, from the name of its chief member, which is preëminent here for the great width and boldness of its outcrop. Not very much work has been done upon any one of these mines, however, and their situation is such as to impose many difficulties in the way of their development by

*It is also to be remarked that these differences in the prevailing mineralization correspond with very considerable differences of horizon; the "silver belt" occupying a position midway, in point of elevation, between the lower, "gold belt," and the higher, doré silver belt, as for readier description it may here be called.

men of small means. No work was doing on any one of them at the time of this visit. These veins have been mineralized by gold and silver ores, the gold forming, it is reported, from 15 to 20 per cent of the assay value of the ores. Their strike is about north 25 degrees west, and they dip east northeast at angles of from 45 degrees to 65 degrees. The mines of the Great Western group, north of the Comstock, at the head of Sweetwater Cañon, come also within this belt.

During the years 1882 and 1883 there was considerable activity in mining in the Patterson District. The Kentuck Mine, on the north slope of Ferris Cañon and near the top of the divide between it and Silverado Cañon, was opened by two adit levels on the vein to the depth of three hundred feet or more below the highest point of the outcrop, and for about four hundred feet in length, and a winze from the lower tunnel explored the vein about one hundred feet deeper. The ore from these workings was treated in a small mill owned by the Kentuck Company, at Clinton, near the mouth of the cañon, where it was crushed by stamps and amalgamated raw in pans. Work on this property was, however, suspended some time during the spring of 1884, and has not since been resumed. Statements respecting the total bullion output from the Kentuck were found to vary greatly: but by one who claimed to speak with knowledge of the facts, as gained from the books of the Kentuck Company, that product was placed, from recollection, at $450,000. If this amount be accepted as approximately correct, the total valuation of the output from all the mines of the district, from 1880 to the present time, is not far from $500,000, something like $50,000 having been produced in small quantities from ts other mines.

The Monte Cristo Company reports a total expenditure of about $40,000 in development work upon its several properties, and in constructing roads, ditches, houses, and a small mill. Considerable ore has been mined from the croppings by an open cut about one hundred feet long by fifteen feet wide, and twenty feet deep. Ninety feet below the open cut an adit has been driven northward on the vein for about two hundred feet, and is connected by two crosscuts with a second drift, which, starting from the first crosscut, runs along the east or hanging-wall for about two hundred and twenty-five feet; from the east drift a winze was sunk one hundred and five feet, where it was stopped by an inflow of water. The foot-wall does not appear in these upper tunnel workings, although the distance between the two drifts on the vein is nowhere less than thirty-two feet. On the hanging-wall is a strong clay gouge, which was followed. The ground has been stoped for thirty feet along the east drift, and for a width and height of fifteen feet and sixty feet, respectively. About one thousand five hundred feet southeast from these surface workings a crosscut tunnel is now driving, which, on August twentieth last, was four hundred and ninety feet long. This tunnel is still in the wide belt of andesitic rock lying to the east of the porphyry in which this vein is found, and it will have to be driven about one thousand feet further to reach the lode, which it is expected to cut at a depth of four hundred and fifty feet below the upper tunnel workings.

The present cost of extracting the ore from this mine, exclusive of prospecting and other dead work, is estimated at $1 50 per ton; the milling expense is placed at $1 per ton. Miners' wages in this district are at present $3 50 per day; millmen receive the same, and outside laborers $2 50 per day. An excellent nut-pine wood is delivered at the mine and mill at $3 25 per cord; timber at $40 per thousand feet, and eight-inch tamarack poles at 6 cents per running foot. Very little timber, however, is as yet required

in the mine. An excellent water right, capable of supplying a fifty-stamp mill, is owned by the company.

The ore is delivered from the upper tunnel, over a trestle one hundred and fifty feet long, into the company's small mill, where it is broken by a Giant crusher (Blake pattern) into sizes of about one inch and less; thence it is automatically fed into two Huntington roller mills, five feet in diameter each, driven by a ten by twelve-inch horizontal engine, at from sixty-five to seventy-five revolutions per minute. The rollers weigh one hundred and fifty pounds each, and there are four in each pan. The pulp is discharged through No. 9, slot-punched screens; below each mill are forty-eight square feet of silverplated and amalgamated copper plates, in sluices four feet wide andtwelve feet long, respectively, arranged in four steps; below which, in the first six feet of the tailings sluice, are placed amalgamated copper plates. In the bowl of each Huntington pan twenty-five pounds of quicksilver are charged at the commencement of operations; and, half-hourly thereafter, about one half ounce additional is added. The tailings are run over blankets fifty feet in length; such concentrations being re-charged with ore in the Huntington pans. The mill is run only ten hours each day; the two crushers treating in that time an average of twenty tons of ore. The wear and tear has not been determined, but it is believed not to exceed in cost that of stamps doing the same work.

Upon the Thoroughbrace Mine at Star City, in Frying-pan Cañon, about one and a half miles west of Cameron by trail, considerable work has also been done. In addition to two tunnels, respectively seventy-five and one hundred and fifty feet in length, and cutting the vein twenty-five and fifty feet below the croppings, a two-compartment vertical shaft was sunk in the east or hanging-wall country to a depth of two hundred and sixty feet. The vein was cut in this shaft one hundred and fifty feet below the surface. The inflow of water became so great at the bottom of the shaft that it could not be handled without putting in pumps. A third tunnel was accordingly started in the spring of 1884, and has been driven in all about five hundred feet, having some four hundred feet more to go to reach the vein, which it is expected to cut about five hundred feet below the collar of the shaft. At present, however, work on this claim is suspended. This lode is reported to be a strong one, but its width was not ascertained.

On the Lady Hayes Mine, located along the south wall of Ferris Cañon and in the Clinton belt, two tunnels have been driven: the upper one two hundred feet long, and seventy-five feet below the croppings; the second tunnel four hundred feet lower and about four hundred feet in length. The vein in these workings is reported to be three feet wide and to have a westerly dip of 45 degrees. No work is doing upon it at present, however.

The Silverado, Homestake, Chrysolite, Poverty, Rattler, and several other mines in this same belt, are also more or less developed by shafts and tunnels, but none of them to any such depth as those heretofore described, though from each some bullion production in a small way is reported.

Specimens of sulphide of molybdenum (*molybdenite*) in quartz, with yellow incrustations of molybdic acid (*molybdite*) were shown and described as having been found in a vein of quartz three feet wide, in a so called "syenite" (hornblende granitite?) on the south side of Silverado Creek, about one thousand feet west from where the trail from Clinton enters Silverado Cañon. This vein is reported to be unproductive in gold and silver, however.

At the north end of the range, north of Sweetwater Creek, and in the cañons cutting down through the west flanks of Sweetwater Mountains, small veins and bunches of argentiferous galenite and some copper ores

are reported to have been found; but such occurrences seem not to have been of sufficient importance to stimulate much activity in prospecting, and no work at all has been done upon such locations for several years.

KEITH MINING DISTRICT.

This district, originally a part of the old Mono Diggings, lies upon the divide forming the watershed for the Walker River and its confluents on the north, and Virginia Creek and other streams flowing into Mono Lake on the south. It was while engaged in sluicing off the auriferous surface deposits from these hill slopes that several small quartz veins were discovered by the placer miners in 1878; and this part of the old placer district was then set apart by them as a quartz mining district. But little work, however, has been done here in vein mining; and not more than two or three men are now engaged in prospecting in the district—the description of which is given from memoranda furnished by one of these.

The veins of Keith District are found in a rock of granitic habit, but so much decomposed and softened near the surface that, in the ground sluicing of the earlier placer operations, it was washed away in one locality, on the Rattlesnake Mine, namely, to a depth of from twenty to thirty feet and for a length of between three hundred and four hundred feet. The veins are very narrow, rarely exceeding two or three inches in width; but they are said to be in places rich in gold. These veins strike northwesterly and dip southwesterly at from 20 degrees near the surface to about 35 degrees in the lowest level on the Rattlesnake vein, upon which the principal work in the district has been done.

The Rattlesnake Mine has an adit three hundred feet long on the vein, though only about forty feet below the surface. From it, near its entrance, an incline was sunk upon the lode one hundred and thirty-five feet, and at a depth of one hundred feet levels were driven north and south from the incline, thirty-five feet and sixty-five feet long, respectively. From those drifts the ore has been stoped to the surface. The average width of the vein is said to be four inches; and the ore, which was worked in an arrastra, is reported to have yielded $35 per ton in gold. After changing hands many times this property has fallen into the possession of several parties now living in Bodie, who are about to resume work upon it. A small, portable, single-acting hoisting engine, together with an extra boiler and two arrastras, are now upon the mine.

A little rich ore is reported to have been taken out, also, from an open cut and shallow incline on the Mono vein, north of and supposed to be a continuation of the Rattlesnake; and several hundred feet west of and parallel to the latter, a somewhat larger vein has also been prospected to a depth of one hundred and twenty-five feet, by an incline shaft, in the bottom of which the ore is reported to be fifteen inches wide. Only a small amount of bullion, however, has been produced from these veins, whose ores were treated in an arrastra. The entire product is stated, on the authority of one of the parties interested, to have been about $40,000 in gold, including, however, what was taken out in the earlier operation by ground sluicing along the croppings.

JORDAN MINING DISTRICT.

This district, which was organized in 1879, lies about ten miles southwest of Bodie, on the east flank of the Sierra Nevada, and extends from Mono Lake and Mill Creek Cañon on the south, to False Castle Peak and the Keith District on the north. Immediately adjoining it on the west is the

Homer District, and on the east it extends several miles over the Mono plains, embracing the auriferous gravel deposits of the old Mono Diggings.

The veins of the Jordan District outcrop along an immense scarp, formed by the Sierra Nevada fault, which has here been modified by erosion into an exceedingly steep mountain slope that rises to the height of some one thousand eight hundred feet above the Mono plain, or about eight thousand six hundred feet above sea level. The lodes occur in a series of highly tilted metamorphosed sedimentary rocks, which form the eastern leg of an anticlinal fold, through which immense masses of granitic and other eruptives of the High Sierra have broken. The other, or western limb of this anticlinal, is seen to the west of these eruptives at the head of Mill Creek Cañon, west of the town of Lundy: and again, further south, at the head of Lake Cañon, where the highly colored siliceous slates form the steep divide over which the Tioga trail leading to the Yosemite Valley passes between Mount Warren and Mount Dana, and through the Tioga Mining District.

With the exception of the Detroit Copper Mine, to be described hereinafter, the principal lodes of the Jordan District thus far opened are gold and silver-bearing quartz veins between limestone and slates. Their general strike is a little west of north, and they dip eastward at high angles, conforming in both respects to the planes of stratification of the inclosing beds. Higher up the mountain, west of the Cleveland Mine, lie the Glasgow and other locations, upon which there has been some little prospecting work, and which are spoken of as occurring between slate and porphyry. This porphyry, however, is a light-colored, compact, hornstone-like rock, such as might have resulted from the alteration of the slates by the action of vein-forming mineral solutions. Upon only two of these Jordan lodes—namely, the Detroit copper vein and the Cleveland—has anything more than a very little development work been done; and such description of them as is here given is based chiefly upon what was seen in the openings on these two mines.

Locally these ore deposits are spoken of as contact veins because found between beds of dissimilar composition: but the so called contact is merely a plane of stratification between rocks which, though of differing constitution, belong to the same geological horizon. The Jordan lodes may be classed, therefore, as bedded veins (von Cotta's *Lagergänge*); provided that term be taken in this instance as not implying that these ore bodies were of contemporaneous formation with their inclosing rocks but simply as indicating that a given fissure chose the path of least resistance presented to it in and along the original planes of separation, or bedding-planes, between different sedimentary strata. These veins, moreover, have probably in respect of their genesis some more or less direct relation with certain igneous rocks which break through them higher up the mountain, and are broadly developed only a short distance to the west, in the Homer District.

Cutting obliquely across the direction of strike of what may be called the Cleveland series of veins, and with a westerly trend, is the Detroit copper lode, above referred to. Its workings, which have been virtually abandoned for several years, were not in condition to permit other than the most hurried and superficial examination, under the circumstances attending the writer's visit. Where seen, however, in the lowest tunnel, the walls of this ore deposit had a dip of 75 degrees to the south. Its copper contents were in an oxidized condition, distributed irregularly through the shattered mass of a much decomposed rock in nodules, seams, and incrustations. Cuprite, chrysocolla, malachite, and azurite were so observed, and the occurrence of native copper is reported. Earthy iron

oxides and manganese abounded; and there was considerable quartz, but not in such quantity as to suggest that it formed even a considerable part of the veinstone. Some very rich masses of cuprite are reported as having been found in the upper tunnel workings. This ore deposit appears to have been formed in and along a zone of fracture and shattering in the metamorphic rocks here, produced by dynamic movements of later origin than those to which the veins of the Cleveland series owe their existence as fissures. Although in its strike the Detroit lode cuts across the other veins by an angle of not far from 90 degrees, yet no faulting of it was observed in the two principal workings upon it which were examined for such occurrences. At the entrance to the lowest tunnel, moreover, where a supposed southern extension of the Cleveland vein, known as the Iron Mine, is seen, this latter lode appears to be faulted by the Detroit; albeit their structural relations were not satisfactorily made out by reason of the present condition of the workings of both.

Shortly after the organization of the district work was begun by the Detroit Copper Mining Company upon the Detroit lode. Subsequently a small copper-smelting furnace was put up; and, as nearly as could be ascertained, about $60,000 worth of ingot copper, in all, was produced. A good deal of work has been done on the mine by three tunnels, the lowest one following along the lode, about six hundred feet below Tunnel No. 1. The enterprise proved unsuccessful, however; and the operations of the company were suspended in the summer of 1883, since which time they have not been resumed.

During the past season a renewed interest has been awakened in the district by developments made upon the Cleveland vein, a controlling interest in which, together with several adjoining claims, has lately been purchased by a San Francisco corporation. A joint shaft is now sinking by this company upon the line between the Cleveland and the Golden Eagle mines, adjoining the former on the north. This shaft is now one hundred and twenty-five feet deep, and the crosscut from the bottom of it is driving westward to the Cleveland vein.

The Cleveland lode is opened three hundred feet vertically below its croppings by a crosscut tunnel to the southwest, three hundred feet long to where it cuts the vein; thence the crosscut is continued forty-eight feet across the lode without having reached its foot-wall. Drifts north and south have been driven upon the ore body along its limestone hanging-wall. The south drift is about one hundred and ten feet in length, the north drift thirty-five feet. Ninety feet south of the tunnel a second crosscut, forty feet in length, and all in ore, has been driven from the south drift. The vein dips eastward about 70 degrees, conforming both in dip and strike with the planes of stratification of the limestone hanging-wall. It is reported that some fifty tons or more of ore from this mine have been worked in an arrastra; but no authoritative information could be obtained respecting the yield therefrom.

The quartz of the Cleveland lode carries gold and silver together with large proportions of the oxides of iron and manganese, a little chrysocolla and other oxidized copper minerals. The greater part of the gold at this horizon of oxidation is probably native, though it is but rarely visible in the ore; the silver minerals are not macroscopically developed, and their character has not been determined. A very little pyrite, blende, and chalcopyrite were noticed; the oxidation of such minerals, however, has apparently been very complete to the depth reached by these workings. On the hanging-wall, just under the limestone, the quartz for a width of ten feet is much more highly colored than elsewhere with oxides of iron and maganese,

and by oxidized copper minerals in a lesser degree; these are arranged in somewhat of the banded structure. Barytes also is found with the veinstone. The portions of the lode west of this ten-foot stratum are less highly mineralized, and the quartz is harder and more compact in texture. In the hanging-wall stratum, however, the veinstone is somewhat saccharoidal; and there has evidently been movement along the lode walls subsequent to the ore deposition.

MONO DIGGINGS.

About six miles north of Mono Lake, and about seven miles northeast of the mouth of Mill Creek Cañon, lie the gravel deposits known formerly as the Mono Diggings, and now included within the limits of the Jordon District. This property has been owned and worked by the Virginia Creek Hydraulic Mining Company since 1882, and embraces three thousand two hundred acres in all. The mining of these gravel deposits has been carried on very intermittently and with varying success ever since 1857, when they were discovered; and the total yield from them is stated to have amounted in all to several millions of dollars, but no record of such product seems to have been preserved, if ever made, and no approximation to the true figures is now to be had from any authentic source.

The material of these deposits consists of sand, gravel, and bowlders of granite, quartz, and slate, with little, if any, clays; and is reported to vary in depth from six to sixty feet. The pay is said to be found, not in well defined channels, but irregularly distributed over areas varying greatly in width, and the character of the workings would seem to indicate this. The source of these gravel deposits is not far to seek in the glacier erroded cañons of the High Sierra, which here debouch upon the Mono Lake Basin, and in whose eruptive masses and metamorphosed sedimentary beds great numbers of gold-bearing quartz veins are found.

The auriferous gravel is mined by cuts, driven into it from bedrock, and the banks on either side are piped down by monitors, the gravel being run through sluice boxes, in which the gold is collected in the way now so well known as to need no description here. The water is brought in a ditch from Virginia Creek, near by. The deposits belong to the class known as "hill diggings," and are capable of very cheap working. The company employs in all at present twelve men. The pipe men receive $4 a day each; the others $3 50 per day. The work is done in two shifts of ten hours each. Mining operations are carried on for only seven months in the year. As nearly as can be ascertained, these placers have yielded about $50,000 in gold since the spring of 1883: and as this amount is here credited, it has been deducted from and does not appear in the bullion shipments by the Bodie banks, etc., given in Table I, although it was all shipped from that town.

DOGTOWN DIGGINGS.

Just north of where the Virginia Creek Company is working, and separated from Mono Diggings by a comparatively low range of hills forming the watershed between the sources of the Walker River on the north and the streams flowing into Mono Lake on the south, is another smaller placer deposit known as the Dogtown Diggings, along a creek of the same name which empties into the Walker River. These deposits, like those of the southern slope of the ridge, are still being mined in a small way, as they have been for many years past. Statistics as to the total production from

these placers were not obtainable. Their output of bullion, like that from the Mono Diggings, has for some years past been shipped from Bodie; but, not being known, it is included in the amounts credited in Table I to shipments from banks and other miscellaneous sources.

HOMER MINING DISTRICT.

About six miles west of Mono Lake, and in the midst of the grandest Alpine scenery, lies Homer Mining District, in two of the eastern cañons of the High Sierra whose lofty granitic crest there forms a boundary between Mono and Tuolumne Counties, dividing the waters which fall eastward into Mono Lake from those that flow westward, through the headwaters of the San Joaquin River, into the Pacific Ocean.

The district was organized late in 1879 from portions of Tioga and Jordan Districts, with some additional territory. It is about four miles long from north to south, by about six miles wide from east to west; though the principal mining activity has been confined to the west half of Mill Creek Cañon, and to its more rugged and picturesque fork called Lake Cañon. Lundy, its small mining town, is situated at an altitude of about seven thousand eight hundred and sixty-five feet above sea level, in Mill Creek Cañon, on the upper (western) end of a beautiful mountain lake nearly one mile in length. Through the lofty southern wall of Mill Creek Cañon breaks the Lake Cañon gorge, whose course is southerly, forming almost a right angle with that of the Mill Creek Cañon; and its *débouçhure* is at the crest of a scarped cliff which rises some nine hundred and fifty feet in height above the little town at its base. The steep granitic walls of Lake Cañon tower to the height of from two thousand to two thousand five hundred feet above its floor, in which, like emerald jewels, are set three Alpine lakelets, the largest of which is nearly half a mile long. At its head, three miles south from Lundy, a precipitous mural cliff of richly colored slates divides Lake Cañon from the north fork of Lee-Vining Cañon, whose waters empty into Mono Lake. In this cliff, and at another point, namely, in the north wall of Mill Creek Cañon at Lundy, can be seen the contact between the slates and granite in vertical cross-section, about one thousand feet in depth at the former exposure, and some two thousand feet or more at the latter. At both places the contact dips to the west at a high angle; while between them, its outcrop curves westward along the broad and lofty crest, whose magnificent eastern escarpment forms the precipitous western face of Lake Cañon. These slates form the western leg of the anticlinal fold to which reference has heretofore been made, and through which the Lake Cañon granitic mass has broken; but it is in this latter rock—a handsome hornblende granitite—that the May Lundy and nearly all of the heretofore productive mines of the Homer District have been found.

In the slates themselves, west of Lundy, in Mill Creek Cañon, a number of locations have been made, upon which considerable work has been done; prominent among which is the group of six patented claims owned by the Homer Mill and Mining Company, on which a tunnel seven hundred feet long or more has been driven, and several short crosscuts run therefrom. Two of their veins (the Nioma, No. 1, and the Gold Hill) are, in their outcrops, among the largest in the district. Their strike is northwesterly and their dip southwesterly, at about 50 degrees. This company suspended operations, however, several years ago, and has not since resumed work upon its mines. A group of ten claims is being opened in the slate district, by the Erie tunnel, driven jointly by the owners of those claims.

This tunnel is now four hundred feet long, but has not yet advanced far enough to have cut the veins for which it is driving.

Several veins, also, are reported to have been opened along the contact, on the broad ridge west of Lake Cañon. Scarcely more than surface prospecting has as yet been done upon them, however. In one of them, the Eagle Bird, it is reported that the vein is from one to four feet wide. Its strike is somewhat west of north, and its dip is nearly vertical, hading slightly to the west, however. Its gangue is quartz, showing some native gold, with which are associated pyrite, a little galenite and blende in small bunches, magnetite and other oxidized minerals. A short adit has been driven along the east (granite) wall, which is there somewhat decomposed, and carries a small gouge.

From two or three mines in the slate belt, west of Lundy, a little ore is being mined. This is milled in an arrastra; but the amount of bullion so produced could not, in the temporary absence of their owner, be ascertained. The ores of the veins in this part of the district contain considerable auriferous pyrite, copper pyrites, some blende, a little mispickel, magnetite, oxidized copper minerals, and native gold which is sometimes visible in the quartz. Upon one of the dumps an abundant formation of native sulphate of iron (melanterite) is going forward by the rapid oxidation of the pyrite contained in the ore. This occurrence was observed at the Erie tunnel, where there was a strong inflow of water from the slates.

The veins of the May Lundy series outcrop along the lofty granite wall above Lake Cañon on the west. They vary in width from a few inches to several feet, and have in general a northwesterly course with a dip southwest at angles varying from 25 degrees to 45 degrees. Structurally they belong to the class of fault-fissures, a type common to regions which, like this, have been subjected to great dynamic disturbance; that is, they are deposits along fracture planes and fissures so produced. The lodes have for their gangue a crystalline quartz considerably colored by iron oxides and often cellular from the oxidation and removal of pyritic minerals. The ore consists principally of native gold, which often shows in the quartz and which is more or less argentiferous. The associated minerals observed were auriferous pyrite, chalcopyrite, magnetite, with other oxides of iron; occasionally a little galenite is seen, and, in the May Lundy at least, the occurrence of mispickel and occasionally native copper is reported to have been observed. The pyritic minerals are not abundant in the upper portion of the vein, where oxidation has proceeded to a considerable extent; but they are found to increase notably in their proportions in the deeper workings. The value of bullion produced from these ores is said to have varied from $13 to $17 per ounce.

There are very many such veins in this series, lying one above another along the precipitous mountain face, and not very far apart; and they are situated at a high altitude, the lower tunnel of the May Lundy, for instance, being over eleven thousand feet above sea level. A few veins of the same character have also been found high up upon the opposite (east) wall of this cañon, but very little work has been done upon any of them. As is the case in all the mining districts organized subsequent to the mining law of 1872, the claims here are one thousand five hundred feet in length by six hundred feet in width. They are all so situated as to admit of mining by tunnels to depths of from five hundred to one thousand five hundred feet.

There has been but little activity in this district since 1884, when the May Lundy Mining Company suspended operations, as the Homer Company had at an earlier date. During the past two years, however, the May Lundy mine has been worked by a few miners under a lease from that

company; and the ore, crushed in a two-stamp custom mill close by, had produced in the season of 1887, and up to September 1, 1888, a little over $36,000 in argentiferous gold bullion.

Since the organization of the district in the fall of 1879, the total bullion output from all of its mines is estimated to have been $1,022,000. About $837,000 of this amount, however, was produced from the May Lundy mine between October, 1880, and the suspension of operations by that company in the fall of 1884.

In 1885 and 1886 there was scarcely any work done in the district; certainly none calling for mention. Renewed activity was stimulated in 1887 by the success attending the operations under lease in the May Lundy mine; and, of the thirty or forty miners now living in the district, the greater number are at present engaged in working upon and developing their own claims, or such as they mine under lease from their owners. The ore thus taken out is milled in arrastras, of which there are three running—two in Lake Cañon and one in Mill Creek Cañon. These arrastras are driven by overshot water wheels, and have a capacity of one and a half tons of ore every twenty-four hours. The milling season at these high altitudes, by reason of the freezing up of the water supply, and the heavy snowfall, is confined to the summer and fall months. But little, if any, mining activity is carried on later than November, or earlier than March, of each year. There are excellent water powers, however, during about eight months of the year in all of these cañons of the Sierra Nevada. Wood for fuel is to be had at Lundy, at $5 per cord; though to supply any very large demand, it would soon have to be brought from a longer distance and at a correspondingly higher price. The wages paid in Bodie District, only twenty miles away, have naturally ruled here, as in all of the adjoining mining districts, namely: mechanics, $5; miners, $4; and general laborers, $3 50 a day, respectively. A ten-stamp gold mill, owned by the May Lundy Company, at Lundy, has lain idle since September, 1884. It was driven by a Leffel turbine (seventeen and one half inches in diameter) under an effective head of twenty-eight feet. Five of the stamps weigh nine hundred pounds each; the other five, seven hundred and fifty pounds each. They were set at seven inches drop, wearing to nine inches; and were speeded to about eighty drops per minute. The pulp was discharged through No. 6, slot-punched screens, set vertically. About 50 per cent of the gold was caught in the battery mortars, the remainder being amalgamated on electro silver-plated copper plates, four and one half feet wide by twelve feet in length, to each battery of five stamps. The tailings were passed over blanket sluices; and the rich pyritous sands from these were treated raw with quicksilver and without other chemicals than a very little crude "soda," in two Washoe pans.

The ore was delivered from the May Lundy by a tramway three thousand five hundred feet long from its lowest tunnel to the floor of Lake Cañon, where it was loaded into wagons and hauled thence to the mill over a road five miles long, costly to construct and expensive to maintain. About six miles of trails were also built by this company. A large portion of this tramway has been swept away by snowslides; and at present the ore is packed on mules, over a trail one and a half miles long, down the steep mountain slope to the two-stamp custom mill at the northern end of Blue Lake.

The developments upon the May Lundy mine consist of three adits on the vein. The upper, called No. 1, tunnel has been driven a little below the highest croppings, and is one hundred and fifteen feet in length; above it the ore has been stoped out for the greater portion of that distance to the

surface. Tunnel No. 2, one hundred and thirty feet below the upper tunnel, is about five hundred and fifty feet long, and stopes have been driven above it to the upper tunnel for a length of about two hundred feet. Tunnel No. 3, about two hundred feet below the middle tunnel, is reported to be one thousand one hundred feet in length. It is connected with the middle tunnel by stopes which are four hundred feet long. Three winzes have been sunk on the vein from Tunnel No. 3, the deepest of which is one hundred and sixty feet. In the bottom the vein is said to be four feet wide, showing some native gold with considerable auriferous pyrite and other sulphuretted minerals; in the lower half of this winze the vein takes a very high dip angle. The length of the stopes, as given above, really represents, however, only the richest portions of the ore body in the workings; for, in consequence of the heavy expense, conditioned by the circumstances under which these mining operations were conducted, all ore of lower grade than $25 per ton in free gold was, by the company's instructions, left in the mine. But these conditions seem to be capable of such modification by means of improved methods of transportation, and in other respects as well, as to considerably reduce many expenses formerly incurred, and thus make profitable the extraction and treatment of much ore yet remaining between the lowest tunnel and the surface. This ore body varies in width from one foot to six feet, with an average thickness of about two and one half feet; but there are places in the stopes where the vein is reported to have been ten to fourteen feet wide.

In the May Lundy mine a series of smaller quartz veins occur, having a north to northeasterly strike and a dip at high angles to the eastward, which are faulted by the May Lundy lode. These veins appear to be coördinated with certain prominent planes of rift having the same general trend with such veins, and plainly to be seen in the granitic walls of Lake Cañon.

In the instances observed in the May Lundy, namely, these faulted veins were from a few inches to two feet in width: one such vein, about eighteen inches wide and dipping southeastward at 60 degrees, had been followed northeasterly for a distance of one hundred feet or more beyond where the May Lundy vein faults it at No. 3 tunnel level; and stopes have been opened in it for a short distance above the drift. Judging by the amount and character of the work done upon them, these veins do not appear to be ore carriers except where near the richer portions of the faulting vein.

Within its boundaries the May Lundy mine has also two other veins, parallel with and successively above the lode upon which the tunnels have been driven; no extensive workings have yet been opened upon them, however, though the higher of them is a strong vein; and little is known of them beyond what is to be seen in their outcrops which appear to be well mineralized and are reported to "prospect well."

The Gorilla mine, also owned by a California corporation, has had considerable work done upon it. Three tunnels have been driven upon the lode: the upper, No. 1, tunnel, is only a short distance below the top of the croppings, and is two hundred and seventy feet long; Tunnel No. 2, fifty-four feet below, is three hundred and forty feet long; this tunnel, near its entrance, is connected by a shaft, three hundred and eighty-six feet in depth, with Tunnel No. 3, which is four hundred and twelve feet long. The vein has a strike of north 40 degrees west, and a dip towards the southwest of about 50 degrees; its average width throughout the workings is two feet. The ore from this mine was first milled in an arrastra; subsequently it was treated in a small mill, owned by the company, containing a Huntington roller crusher, four feet in diameter, driven by an overshot waterwheel.

The mill is supplied with the necessary equipments of copper plates, etc., and is located at Lundy, in Mill Creek Cañon.

The total bullion output from this mine is reported by its Secretary to have been $61,773, all of which was produced in the years 1882 to 1886; in which latter year work upon the mine was suspended by the company. In the summer of 1887 a little ore was extracted from the Gorilla mine under lease; but the bullion product therefrom could not be ascertained. It is stated that the Gorilla Mining Company is preparing to resume work upon their mine during the present fall.

Upon the Jackson, Bryant, Lake View, Golden Prince, Collamore, Josie Green, and Cora veins more or less development work has been done, and ore extracted and milled, whose product is included in the total estimate given on page 369. These mines are all located in Lake Cañon, and are members geologically of the May Lundy series, having the same structural features and relations and a like mineralization with it. Upon all of them, in a small way, more or less work is still doing; and the two-stamp custom mill, together with the two arrastras in Lake Cañon, are kept busy upon their ores in turn during the milling season.

TIOGA MINING DISTRICT.

Immediately adjoining the Homer District on the south, twelve miles west of Mono Lake, and stretching between Mount Conness on the north and Mount Dana on the south, is Tioga Mining District, situated on the summit of the Sierras, at the head of Lee-Vining Creek. Yosemite Valley is distant only about twenty miles southeastward, and the intervening region is one of surpassing beauty, grandeur, and picturesqueness. Lundy, the nearest town from which supplies can be drawn, is distant nine miles northward, and the Tioga District is reached from it by a precipitous and difficult trail over the Tioga Pass between Mount Warren and Mount Dana. Above this rugged crest, itself more than eleven thousand feet above sea level, tower granite peaks which, in Mounts Dana, Gibbs, Conness, and Lyell, rise to altitudes of over thirteen thousand feet, and which still bear upon their northern slopes the remains of great glaciers that once covered immense areas over this grand mountain complex. Granitic bowlders, many of huge size, are scattered everywhere over the surface, and wherever exposed to view the underlying slates are polished and furrowed with glacial groovings which here, at Bennetville, have a prevailing northwesterly trend.

Bennetville, where the Great Sierra Mining Company's offices and buildings are situated, is nine thousand eight hundred feet above sea level; and the mines outcrop on a broad, plateau-like crest rising just above it on the west, at altitudes of from ten thousand six hundred to ten thousand eight hundred feet above sea level. From this mining town the Great Sierra Mining Company built in 1882–83, at a reported cost of $64,000, a wagon road, fifty-six miles long, to Crockers, in Tuolumne County, by way of Lake Tenaya and Yosemite Creek, passing only a little east of the famous valley. This road was built for the purpose of bringing machinery and supplies to the mines over the more accessible route offered by the less precipitous western flank of the Sierra Nevada.

No capital has been invested in this district save that by the Great Sierra Consolidated Mining Company; which owned two adjoining claims, aggregating three thousand feet in length, on the Sheepherder lode, four contiguous claims of fifteen hundred feet each on the Great Sierra lode, and several other outlying locations; all secured by United States patents.

After expending, it is reported, in the neighborhood of $300,000, this company suspended its operations through financial disaster in July, 1884; since when no work other than that done each season by a few prospectors upon their claims, has been carried on in the district.

The mining operations of the Great Sierra Company were directed almost entirely to the development of the Sheepherder and Great Sierra lodes by a crosscut tunnel begun in May, 1882, which should reach them at depths of seven hundred and fifty and eight hundred and thirty feet, respectively. These two veins at the surface are about nine hundred feet apart, with the latter vein as the westernmost; and their outcrops are unusually strong and are traceable for long distances. When work was suspended in 1884, that tunnel was one thousand seven hundred and eighty-four feet long and just under the Sheepherder croppings, vertically, having an estimated distance of about two hundred and seventy feet still to run before cutting at this horizon that lode, which, at the surface, has a dip to the west of about 70 degrees. The tunnel has been driven as a double track adit, six feet wide and seven feet high in the clear, and with one track laid. Its course is south 31 degrees 30 minutes west, magnetic. A large stream of water is flowing from the tunnel, coming it is said, from the Tallon vein, which, where cut at about one thousand four hundred feet west of the tunnel entrance, is reported to be six feet wide.

In January last all the property of the Great Sierra Company, including its long wagon road, was purchased at Sheriff's sale for $163,000 by a few New England parties who had been large shareholders in the old corporation. And it is reported that work upon these mines is to be resumed as early as practicable in the spring of 1889.

The lodes of the Tioga District occur in a highly-tilted and folded series of metamorphosed sedimentary beds whose members are composed of siliceous and graphitic slates, quartzites, and certain gneissoid rocks very poor in mica. The dip of these strata is to the southwest at high angles, and they strike in a northwesterly-southeasterly direction. Geologically they form a part of the series heretofore described as constituting the western limb of the anticlinal fold broken through by the Lake Cañon granitite and other igneous rocks.

The Tioga lodes on the surface are large ones. In the instances observed they were from ten to fifteen feet wide on the average, though in some places not more than six feet, and in others as much as forty feet between walls. Their strong croppings are traceable for long distances.

At a point on the southern edge of a small meadow on top of the broad, mesa-like ridge on which these veins outcrop, the Great Sierra lode forks in going south; and its east and west branches ultimately become separated by an interval of from three hundred to four hundred feet. Between the two branches occurs an intrusive rock of greenish-gray color and coarse texture, and having macroscopically the appearance and something of the habit of a basalt. This same rock is reported to form the mass of Pilot Peak, a bold, conical hill, rising about one mile away to the south. Coincident with this occurrence there is observable a marked alteration in the structure and apparently in the mineralogical composition of the wall-rocks of the two veins on either side of this basaltic tongue, or dike as the case may be. In place of the characteristic slate structure, which is here no longer apparent, or but imperfectly developed, a fissile structure is seen and the habit of the rock has become somewhat like that of a gneiss poor in mica. Both in dip and in strike these lodes follow the stratification plane of their inclosing slates. Too little work, however, has been

done upon the lodes themselves to determine what are their true structural relations.

The veinstone of the Tioga lodes is a white, crystalline quartz; and the ores are argentiferous and auriferous mixtures of pyrite, copper pyrites (chalcopyrite), zinc blende (sphalerite), with subordinate occurrences of bornite, mispickel, and galenite. The tenure in gold is reported to be much less than in silver, and is said to vary from mere traces to $8 per ton. No metallurgical operations have as yet been carried on in this district; and the returns from several small lots of ore shipped to San Francisco and other points for experimental treatment were not obtainable.

LAKE MINING DISTRICT.

In the southwest corner of Mono County, about twenty-five miles south of Mono Lake, and, like Homer and Tioga Districts, situated in the very heart of the High Sierra, lies Lake Mining District, which was organized as such in June, 1887. The town of Bodie is distant about fifty miles north by east, by road; and that of Benton forty miles east northeast. Within a radius of ten miles from the center of the district at Pine City, just above Mammoth City, are fifteen mountain lakelets, one of the largest of which (Lake Mary), by whose borders the upper town (Pine City) is situated, is one and one half miles wide by three fourths mile broad, and is said to have a depth of two hundred and fifty feet at one place. Mammoth City is at an altitude of about eight thousand three hundred feet; Pine City, about eight thousand five hundred feet. The mine workings are from five hundred to one thousand feet higher. The veins are so situated in most instances as to allow of their being opened and drained to nearly the whole of this depth by adits. At the head of the cañon, above Pine City, the Sierra Nevada crest turns somewhat more to the southeast, and is not so high there as at the several passes in the cañons further north and south of it. From its western slope at this latitude the headwaters of the North Fork of the San Joaquin River take their rise; while the drainage from its eastern and more precipitous flanks forms the sources of Owens River, which pours finally into Owens Lake, at the eastern base of Mount Whitney, the highest peak of the Sierra Nevada. Over Mammoth Pass a railroad route was surveyed in 1881.

In the spring of 1878 the Mammoth Mining Company began work upon the Mammoth mine, and there was considerable mining activity about the towns of Mammoth and Pine City until the winter of 1881, when, following the suspension of the Mammoth Company's operations, the camp was rapidly deserted, and half a dozen prospectors are all that now remain of a population estimated at fifteen hundred souls in 1879. These few men have been engaged intermittently, since 1884, in getting out ore from the Mammoth and Lisbon mines, under leases. They mine during the winter months, and during the summer season they work the ore in an arrastra, at Pine City.

The Mammoth, Headlight, and Monte Cristo mines, supposed to be upon one and the same vein, with the Mammoth as the northernmost, were respectively owned and worked by San Francisco corporations. Southwest of the Monte Cristo lies the Lisbon, the property of private individuals. These four are the only ones in the district upon which any considerable work has been done; and of these only the Mammoth and Lisbon are reported to have produced bullion.

These lodes are spoken of locally as occurring between porphyry and quartzite, with the former as a hanging-wall. On the occasion of this visit,

however, the hanging-wall could not be seen. It is reported to have been reached at only one place in the district, namely, in an east crosscut from No. 3 tunnel, of the Mammoth mine; but these workings were in a partially caved condition and were not examined.

The term porphyry, it is to be remarked, as used by miners, is applied to a very large number of rock species, without reference to or knowledge of their mineral constitution. No true porphyry was seen by the writer, however, among the rock debris in the cañon below the mine.

At the only place underground where the foot-wall was seen, namely, in a short crosscut from the Mammoth vein, at No. 2 tunnel level, the rock had there the appearance of a compact, light-colored hornstone, such as might have resulted from an alteration of siliceous slates by the mineralizing action of vein solutions. Such slates are found, moreover, a little further west, where they have been cut by the Monte Cristo and Lisbon tunnels; and they are reported to be very characteristically developed in the sections made by those crosscuts.

On top of the mountain rising south of the town of Mammoth, and in which the veins are found, is a capping of a basaltic rock, which has a micro-crystalline ground mass, and is richly porphyritic with disseminated olivine granules of a characteristically greenish-yellow color; the contrast between which and the light-gray ground mass gives to it a strikingly attractive appearance. This rock is reported to be found further south, cutting through the mountain in dikes which have prevailingly an east-west course; but in none of the mine workings, it is stated, have any such dikes been encountered.

The veins of the Mammoth series strike northwesterly and dip eastwardly at 70 degrees to 80 degrees, conforming in this respect with the stratification planes of their inclosing rocks. The veinstone of their ore bodies is generally a hard, semi-crystalline to crystalline quartz. Near the foot-wall in the Mammoth Mine it was observed to be more or less saccharoidal, as though it has been comminuted by rock movements. Through this quartz the pay ore is distributed in bunches and spots, the veinstone being mineralized by magnetite and other oxides of iron and by auriferous pyrite, chalcopyrite, bornite, blende, and native gold. Although no characteristically developed silver minerals were observed, these ores are argentiferous.

Such bullion as has been produced from this district is reported to have been valued at from $7 to $16 per ounce; but as to the total bullion product from its mines it was found impossible to gather trustworthy statistics; all records had long since been removed and no one was found who could speak from any positive knowledge of the facts. Indeed, the very methods which appear to have been employed in shipping the product were such as to make the collection of information respecting its amount, exceedingly laborious, if not altogether impracticable. The bullion was shipped not alone from Mammoth, but sometimes from Bodie or Benton, and one large lot of exceedingly rich gold ore was sent to San Francisco. Nearly all of the amount shipped from this district, however, was produced from the Mammoth mine; and the prevailing opinion of a few who lived in Mammoth City during the productive period, places the total output of that mine at about $200,000. In addition to the yield from the Mammoth mine, the production from all other sources, up to the first of September of the current year, has probably not exceeded $20,000.

The Mammoth mine, whose ore body is from fourteen feet to forty feet and more in width, has been opened by four adits to a depth of about one thousand feet below its highest croppings. Tunnels No. 2 and No. 4 are

reported to be over one thousand five hundred feet in length, each. The rich ore body which caused so much excitement in Mammoth stock in 1879, was found between Tunnels No. 3 and No. 2, or about five hundred feet above the lowest tunnel (No. 4); but this bonanza proved to be very limited in extent. In the lowest tunnel there seems to be a question in the minds of those familiar with the mine, as to whether the Mammoth vein had been cut or not at that horizon. It is quite certain, however, that no pay ore was found there. This tunnel seems to have been run diagonally towards the vein; and it may be that it was continued in the more or less mineralized and altered slates near the lode, and had not yet reached the vein itself. No crosscut seems to have been driven from this tunnel, so far as could be learned, to determine this important point. From this lowest adit there is a large flow of water, estimated to be between two hundred and three hundred gallons per minute.

In the summer of 1878, a twenty-stamp mill was put up by the Mammoth Company, to which twenty stamps were added the following spring. The stamps weighed nine hundred pounds each. The mill was driven by a six-foot Knight wheel, under an effective head of about one hundred and seventy-five feet. Provision had also been made to drive the machinery by steam; but no occasion seems to have arisen for the application of that power. No provision, however, seems to have been made in this mill to concentrate and save the pyritic minerals in the tailings. Samples of such concentrates, crudely separated by hand panning from the arrastra tailings, are reported to have given high assay returns both in gold and silver; and such tailings are now being concentrated on blanket sluices by the parties who are at present engaged in extracting and milling the ores from this mine.

By the Headlight and Monte Cristo Companies a joint crosscut tunnel was driven from the west, at a depth of eight hundred feet below the surface. In this tunnel, which is reported to be over one thousand five hundred feet in length, a vein of low grade quartz was cut at a distance of about one thousand two hundred feet from the tunnel mouth. After driving the tunnel three hundred feet beyond this vein, all further work on these two mines was suspended and has not since been resumed.

At the Lisbon mine, about three miles south of Pine City by road, three adits were driven on the vein about one hundred feet apart vertically, the lowest one being something less than three hundred feet below the croppings. This lode strikes northeasterly, making a large angle with the trend of the Mammoth series of veins. One of the latter is reported to have been cut in the Lisbon ground by Tunnel No. 3; and if the description given of the relation of the two lodes at this point be correct, the Lisbon vein appears to be the younger and to fault that of the Mammoth series.

The Lisbon lode is reported to be about two feet in width, and the ore a free milling gold quartz, with more or less auriferous pyrite, and without much occurrence of the more complex metallic sulphides common to the Mammoth series of veins. Several hundred tons of ore from this mine were crushed in a five-stamp gold mill owned by the Lisbon Company; but no one was found who could give authentic information respecting the amount produced. At intervals since 1881 a little ore has been extracted from this property under lease from its owners, but no work has been done thereon during the present year.

BENTON MINING DISTRICTS.

Benton, the oldest, and until the rise of Bodie, the most important mining town in Mono County, is situated in its southeastern portion, twenty-four miles north of the boundary between Inyo and Mono counties, and about seven miles west of the State line separating California from Nevada.

This town lies in a basin-like depression, between two subordinate granitic ridges, rolling westward like huge billows from the base of the White Mountains. It is at an elevation of about five thousand five hundred feet above sea level. One of these ridges, Blind Spring Hill, namely, immediately east of Benton, rises to the height of about one thousand two hundred feet above the town, and constitutes Blind Springs Mining District, which, in respect of the extent to which its mines have been opened and the amount of its bullion product, is the most important of the several mining districts included within the Benton group, and having that town as their common distributing center for supplies.

The White Mountains, in Mount McBride the extreme northwestern peak of the range, are reported to rise to an altitude of over thirteen thousand feet above sea level; and they form, with their white, serrated pinnacles, the most prominent and striking feature in the landscape, with the exception of the High Sierra, for one hundred and fifty miles or more around. This range is undoubtedly much older than the Sierra Nevada. Mr. Goodyear* reports that in Inyo County, where these mountains are known as the Inyo Range, he found in 1870 some small crinoids and corals of upper Silurian type; and that his investigation of that mountain mass then, and very recently, leads him to place its age as that of late Silurian or early Devonian.

Within the distance of twelve miles of Benton, though all but one are much nearer than that, are four mining districts, all of which have at one time or another been, in a greater or less degree, bullion producers. These are Blind Springs District, immediately east of the town; White Peak District, in Montgomery Cañon, seven miles east of Benton, and in the White Mountains proper; Indian District, about eight miles a little south of west; and Clover Patch District, about twelve miles southwest from Benton. During the past six years or more, however, there has been very little production from three of these districts; nor, saving in Blind Springs District, were any mining operations going forward at the time of this visit, other than the so called "assessment work" in one or two instances. In Blind Springs District a few men are at present employed in getting out the ore from the upper workings of two or three of the older mines, under lease from their owners. The other outlying districts were not visited, and the information concerning them is entirely at second hand.

Until June last, a five-stamp mill owned by the Wai Wera Company, at Benton, was employed upon ores from Blind Springs District, and occasionally, upon such small lots as were brought in from time to time from one or the other of the neighboring districts. In the latter part of that month the mill burned down; but it is expected, however, that a new mill will be rebuilt before the summer of 1889. Statistics respecting the total bullion production from the several Benton Districts were obtained from a gentleman† well qualified by his position and term of residence at Benton

*Mr. W. A. Goodyear examined this whole region in 1870, at which time he was a member of the geological corps under Professor J. D. Whitney, then carrying on the California Geological Survey.

†Mr. J. F. Millner, Wells, Fargo & Company's agent at Benton, since 1881, and owner of the Wai Wera and several other of the mines there.

to give very close approximations and, in some instances, accurate returns: and it is to his courtesy that the Mining Bureau is indebted for the following memorandum of its bullion product:

VALUE OF BULLION AND ORES SHIPPED FROM BENTON, CAL.

Estimated value of bullion and ore shipments, from 1862 to 1871	$1,500,000 00
Value of bullion as per shipper's valuation, from 1871 to 1881	2,853,967 59
Value of bullion as per assay valuation, from January, 1881, to October 1, 1888	278,594 09
Net returns from lead ores, from 1881 to 1887	9,290 63
Net returns from miscellaneous ore shipments, from January, 1887, to October 1, 1888	4,016 99
Estimated value of ore shipments other than above, from 1881 to October 1, 1888	70,000 00
Total	$4,715,869 30
Less estimated value of bullion from Indian Queen Mine, in White Mountains, State of Nevada, shipped through the Benton office prior to 1882	500,000 00
Total value of production from mines of Benton District, from 1862 to October 1, 1888*	$4,215,869 30

Of the above total product, Blind Springs District is credited, according to Mr. Millner's account, with an output of $3,945,869, while the remaining $270,000 is apportioned to the three outlying districts, as follows: White Peak (Montgomery Cañon), about $60,000; Indian District, $150,000; and Clover Patch, $60,000. More than one half of the output from Blind Springs District, namely, $2,200,000, was produced by three mines; the Comanche being credited with $1,000,000, the Wai Wera (embracing the older Diana and Karrick locations) with $900,000, and the Cornucopia with $300,000, approximately. The remaining $1,745,869 was the yield from a number of other mines in amounts of from $50,000 and less to $200,000.

During the earlier years, the ores from the Montgomery and Blind Springs districts were for the most part shipped at great expense to Reno or San Francisco for treatment; following the failure of one or two attempts to smelt them at Benton as copper ores. Subsequently, some acquaintance with metallurgical methods better fitted to the character of these ores and the economical conditions obtaining in the district, having been meantime acquired, the ores were treated in three or four small mills put up at and near Benton. The best equipped of these were the Comanche, at Benton, since moved away, and the Indian Queen mill, about twelve miles east by north from that town. There is at present no establishment at Benton for the beneficiation of ores; the five-stamp mill owned by the Wai Wera Company having burned down, as before stated, last June, up to which time it was pretty constantly employed. The only neighboring mill now in serviceable condition is that owned by the Indian Queen Mining Company, and situated in Nevada; this has eight stamps (weight not known), four pans, two settlers, and one White & Howell revolving furnace. The Wai Wera Company, however, treated the ores raw, crushing through a wire screen of sixty meshes to the linear inch, and with a duty of two and one half tons per stamp head per twenty-four hours. The pulp was charged into pans with (?) pounds quicksilver, 12 per cent salt, 0.5 per cent sulphate of

*This production was almost wholly silver, whose value was calculated at $1.2929 per troy ounce. No allowance is made in the above table for the increasing discount on that metal since 1862, nor is the amount of such discount in the above instances now known. So small a value in gold is contained by the Benton bullion that it is rarely taken into account.

copper, and three pints (or less according to character of ores) of sulphuric acid (60 degrees Baumé) per one and one fourth tons ore (dry weight). This charge was heated to 160 degrees Fahrenheit by steam, and amalgamated eight hours.*

An examination at Benton of two collections of ores from all of its outlying districts showed a marked uniformity in the prevailing character of their mineral constituents. They were all essentially more or less complex associations of antimonial ores of copper, lead, and silver, with, usually, scarcely more than traces of gold.

The minerals observed in the ores of these two collections were pyrite, chalcopyrite, bornite, gray copper ore (tetrahedrite), sphalerite, galenite, argentite, pyrargyrite, stephanite, kerargyrite, native silver, magnetite, partzite, hematite, anglesite, and cerussite. Only a small number of these, of course, were observed in any one association, the prevailing minerals being, generally, the sulphurets of iron, lead, and zinc, with antimonial silver minerals. Native copper was an occasional occurrence. In the deeper mines of Blind Spring Hill, antimonial gray copper ore is reported to have replaced the partzite below the so called water level.

For several years past there has been no mining activity in any of these districts except in that of Blind Springs; although in all of them sufficient work is done each year upon a few claims to comply with the provisions of the mining law. Only the Blind Springs district, therefore, was visited; and such slight information as is here given respecting the three other districts, was gathered chiefly from a few who still retain mining interests therein.

The mines in Montgomery District occur for the most part in limestone, though a few are said to lie in granite. Of the latter, the Silver Glance was instanced and described as a very small vein, rich in the mineral which gives name to the mine. The two lodes, upon which the most work is reported to have been done, and which have yielded the greater portion of the output from this district, are the Phœnix and the Mountain Queen (now Creekside). These veins are described as occurring with limestone for a hanging-wall, and, for a foot-wall, another calcareous member† of the metamorphosed sedimentary strata lying against the White Mountain granite. The veins strike northeasterly and dip northwesterly at comparatively low angles, conforming in both respects, it is said, with the stratification of the inclosing rocks. Their width varies considerably, but it is stated to be about three feet as an average. The ore bodies occur in bunches which make into the limestone hanging, never into the foot-wall; and the ores are argentiferous mixtures of lead, copper, iron, and zinc sulphurets, with rarely more than traces of gold. The lowest working upon any of these veins is reported to be about one hundred and thirty feet below croppings.

The Indian and Clover Patch districts were consolidated into one, in 1885, under the name of Indian District, covering a large area of the country west and south of Benton, and, as might be supposed, presenting considerable variety in its stratigraphical and structural geology. Only three of its mines have been producers, however, so far as was ascertained,—the Wild Rose and Banner in the Clover Patch section, and the Tower Mine in the original Indian District, and about three miles south of Blind Spring Hill.

The Banner lode is reported as running northwesterly, with a very flat dip towards the southwest. It was worked by several short adits to a

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* Letter from Mr J. F. Millner, of Benton.

† Reported as a "lime conglomerate."

depth of perhaps one hundred and fifty feet on the slope of the vein, and was stoped thence to the surface. A small mill was put up near the mine in 1882, but no mining operations have been carried on there since 1884.

The Wild Rose mine was opened by drifts and stopes from an incline less than two hundred feet long, sunk upon the vein, whose dip was 45 degrees westward, and its trend a little west of north. In the bottom workings the vein is reported as very wide, but as containing a much lower grade of ore than it did above where the space between walls was only four feet.

Both the Wild Rose and Banner lodes carried a notable content in gold. Some of the bullion is reported as having been about 700 fine in gold and 300 fine in silver; or, reduced to percentage weights, about 13 per cent of gold and 87 per cent of silver. But the general run of the bullion from these mines is reported to have had a value of from $2 50 to $3 per ounce.

In 1876 work was begun upon the Tower mine. This vein occurs in granite, and has a northerly strike and a westward dip of 75 degrees to 80 degrees. The ore is found distributed somewhat irregularly in bunches or kidneys of richly argentiferous pyritic mixtures in a quartz veinstone, the associated minerals being chiefly blende, pyrite, and some galenite, with pyrargyrite and other antimonial silver ores. An incline shaft followed the lode to a depth of about one hundred and ninety feet, and from it several levels were opened along the vein. The ore stoped from these workings was treated in the Comanche mill at Benton, the total product amounting to about $150,000, as before stated. A new shaft was afterwards sunk about three hundred feet west of the incline, and was equipped with hoisting machinery and pumps costing, it is reported, about $60,000. This shaft was sunk vertically about two hundred and eighty feet, when all further work was suspended in 1882, since when it has not been resumed. The vein was never reached in this shaft, nor was any crosscut driven to it therefrom, the strong inflow of water encountered in sinking having been given as a reason, at the time, both for the failure to crosscut and the subsequent suspension of all work on the mine.

Blind Spring Hill, in which the Comanche, Wai Wera, Cornucopia, Borasca, and other mines occur, is about six miles from north to south by about three miles from east to west. Its eastern flank is so abrupt as to be precipitous in many places, particularly on its northern end, and down to its very foot sweeps a broad talus from the western flank of the White Mountains, across the floor of the narrow Blind Springs Valley, through which the Carson and Colorado Railroad now runs. The western slope of Blind Spring Hill has a much less abrupt descent, and the approach to its mines is from this side. Viewed from the west the crest of this mountain falls by the gentlest slope to the north until its contour there merges gracefully into the plain at the northwest base of the White Mountains. At its southern end this hill falls very much more rapidly down to Yellow Jacket Creek.

This mining district was organized early in 1864; following the discovery of the Cornucopia, Diana (now Wai Wera), and Comanche veins, within a few days of one another, and in the order named; and soon, as usual, the entire mountain was speedily covered by locations.

The rock in which the lodes of Blind Springs District occur, is a very coarsely crystalline hornblende-granitite, in which the orthoclase crystals are often very large, measuring in some instances observed, three inches in length by one inch in breadth. This granitic mass has been subjected to at least two series of dynamic movements, with both of which certain in-

trusions of eruptive rock are associated. This is evidenced by the structural relations observed by the writer in the Lyford mine, and by those reported by Mr. Goodyear as obtaining in the Kearsarge mine, which he visited in 1870. These two mines will be briefly described further on. By the earlier of those dynamic movements, the fault-fissures were produced which now constitute the principal veins of Blind Spring Hill, both as respects extent and productiveness, and which, in the case of the Kearsarge, and perhaps of the Comanche, also, are directly related with intrusive rock masses. To the later movement must be referred a series of eruptive dikes which cut through the Blind Spring granite in a nearly east and west direction, and with a very high dip angle, inclining, however, a little to the north. Wherever such dikes or their coördinated and approximately parallel fractures have been met with in the several mine workings, they fault the older fissures.

The Comanche vein is the largest, as it was the most productive, on the hill, and it is said to be traceable for nearly one and a half miles. It outcrops only a little below (west of) the crest of the granitic ridge, and follows the general trend of the mountain, about north 20 degrees west, having an average dip eastward of about 80 degrees. To the east of, and in the main parallel with, the Comanche, lie the other principal lodes of the district—the Wai Wera, Cornucopia, Borasca (formerly Neilson), and the Lyford (formerly Rockingham). These all dip eastward at angles varying from 30 degrees to 45 degrees.

The ore bodies of these lodes occur in irregular masses, which, however, in their mutual relations of direction, have a dip toward the south in the plane of the vein, and are found now on one wall, again passing to the other. The walls are generally smooth, especially the foot-wall, and often show slickenside surfaces, which latter occurrence, it is reported of the Comanche, was always associated with, and so came to be looked upon as an indication of, rich ore.

To the west of the Comanche are found a series of narrow veins, which in several instances have been moderate producers. These smaller fissures form an acute angle of a few degrees with the strike of the Comanche series. They dip westward at such low angles that they are called, locally, "blanket veins," and, from the conditions of the case, have only been worked to depths of from eighty to one hundred and twenty-five feet. No opportunity could be had for examining even hurriedly the structural relations of these smaller veins. In the mineral character of their ore bodies they are reported to be the counterpart of the principal lodes; but, unlike the latter, have their foot-wall broken. More or less comminution of the vein contents is reported of all of the Blind Springs lodes, the quartz being in some places in a "sugary"* condition, in others "very hard and flinty,"† and often in angular fragments.

The Comanche mine was opened by an incline on the vein, about seven hundred feet long, and by drifts therefrom. This lode is reported to have "an average width of five feet between well defined walls, with an easterly dip of 82 degrees."‡ Its pay shoot is reported to have been not over two hundred and fifty feet in length. "At the south end of this shoot the walls were perfect, but the fissure was filled with barren quartz, iron ore, and clay; while at the north end the vein was cut off by a vertical dike or crossbreak, and not found on the north of it, as far as prospected."§ This break or fault can be seen on the surface, about six hundred feet north of

*Quoted from letter of Mr. J. F. Millner. †Ibid. ‡Ibid. §Ibid.

the Comanche incline, where the displacement appears to have been along an east to west fault plane. North of this fault several hundred feet, a tunnel has been driven eastward something over two hundred and fifty feet, and about seventy-five to one hundred feet below the surface, at its face. Admittance to this tunnel was refused; but it is reported to have cut a vein of good ore, which is at present being mined under a lease from the Comanche Company; and it is probable that the tunnel has recovered the Comanche lode, north of the throw. Strength is given to this probability from the structural relations observed in the Lyford mine, only a short distance east of the Comanche, where the movement of displacement along a faulting east-west dike has been downward and eastward along the northern or hanging-wall plane of that faulter. The Comanche workings could not be examined, however, as the hoisting works and machinery were removed from the mine several years ago. Its ore is reported to have contained more copper than that of any of the other mines.

The Kearsarge mine, about three quarters of a mile south of the Comanche shaft, was opened by two incline shafts about three hundred feet apart, and both sunk upon the vein, following its nearly vertical dip of 85 degrees. The north incline was two hundred and fifty feet deep; the south incline, starting from a point on the croppings about ninety feet higher, was sunk four hundred feet. Except the ore body followed from the surface to where it gave out before the two hundred-foot level was reached, no other bonanza was found in this mine, although the vein was followed nearly one thousand two hundred feet at the two hundred and fifty-foot level. It is believed to be a continuation, southward, of the Comanche lode; and, like the latter, outcrops only a little below the ridge crest. In the lower workings, the fissure, though barren, was well defined, with walls four to five feet apart; its strike is about north 10 degrees east.

This mine was visited by Mr. Goodyear in 1870, and in his notes made at that time, he speaks of this fault-fissure as being "a small quartz vein * * * from one inch to two and three feet wide * * * between the granite and a trappean dike;" with the granite as its east and the dike as its west wall. Essentially the same general mineral associations were observed by Mr. Goodyear in this mine as are hereinbefore enumerated in a description of the Benton ores; but he notes the occurrence of copper and lead minerals as being in small quantity.

The old Diana and Karrick Mines, both upon the same lode, and a little east and south of the Comanche, have been consolidated into one property, under the name of the Wai Wera.

In common with the Cornucopia, Borasca, and several other mines, the Wai Wera belongs to the older, or Comanche, series of veins, and has been worked to a depth of something over seven hundred feet, by an incline on the vein and seven levels therefrom. In their structural features and mineral constitution these veins are like the Comanche. The Diana is faulted on its north end by an east and west trending, brecciated zone, along which a gulch has been eroded. A distance of nearly half a mile separates the Comanche and Diana faults, with the former as the northernmost. Some prospecting work is being done in the latter mine.

The Cornucopia and Borasca have been worked to depths of between three hundred and four hundred feet, respectively, and the Borasca is still being mined in its upper levels, under a lease from its owner. The former mine lies a little east of, the latter north and east of, the Comanche.

Respecting the other mines of the district, but little authentic information could be gathered. It was ascertained, however, that none of them

had been large producers, and that they had not been worked to any great depth; but in nearly all of them more or less rich ore was found at and within one hundred feet below the surface.

A series of very small veins is also found on Blind Spring Hill, of which the Humboldt, lying between the Comanche and Cornucopia, is an instance. This vein had a course a little south of east, and a dip northward at a low angle. Too little work, however, has been done upon any of this series of veinlets to determine their true structural relations. They were not found to be ore carriers to any important extent, and were, therefore, not followed far in any direction. From what was seen of the Humboldt croppings, and of their relation with respect to those of the Comanche, it appeared as though the former vein, together with coördinated members of the same series, were in some way dynamically related with the east-west faulting dikes before referred to and more particularly described in the one instance in which the same could be observed underground, in the Lyford workings; namely.

The Lyford mine, situated above (east of) the Comanche, and on the eastern flank of the mountain a little below its ridge, was examined in its underground workings at the level of the main tunnel, which is about four hundred feet long; and at two other, shorter tunnels, above. In these workings the vein was found faulted by a dike: along and near which on its northern side the principal stoping had been done on the Lyford vein, as though here, in more or less close proximity to the dike, the best ore had been found. This dike was four to five feet wide; it had a strike a little south of east, magnetic, and a dip to the northward of about 85 degrees, parallel with which elements the dike was somewhat thinly sheeted. This intrusive rock had a slightly conchoidal fracture in a direction at right angles with its structural planes; and in its light gray, compact ground-mass crystals of plagioclase and biotite were observed. It resembled certain mica porphyrites, though its true species could, of course, only be determined microscopically. The structural evidence of extensive rock fracture and displacement are well seen here on the north side of this dike, in a wide zone of breccia with nearly white, clay casings, showing slickenside surfaces and striations. Along this breccia and using the more solid dike as a footwall, a raise was made, evidently in search of the vein, but quite on the wrong side to find it. Other workings, very irregular and evidently without definite plan, have been made south of the dike at this level, but in none of them has the faulted portion of the vein been recovered.

This mine, formerly the Rockingham, is reported to have produced in all about $200,000, and it is probable that in this, and in others of the mines in this district of somewhat complex and interesting structural conditions, a wisely planned system of exploitation, such as should be based upon knowledge of their structural relations, would result in a recovery of the lost ore bodies and give a new lease of life to some of the mining enterprises on Blind Spring Hill.

BODIE DISTRICT.

This district, situated about twelve miles a little south of east from Bridgeport, and ten miles due north from Mono Lake, has for its center the town of Bodie, close to which all the mines of the district are located. The town itself is distant, by wagon road, twenty miles from Bridgeport, and forty miles southwest from Hawthorne, on the line of the Carson and Colorado Railroad, with which point it is connected by a daily stage and mail service.

Bodie Mining District was organized July 10, 1860. One year later the Bunker Hill lode (now a part of the famous Standard mine) was discovered. In the fall of 1863 a number of Bodie mining companies consolidated their claims, which, with millsites, tunnel rights, etc., were purchased by the Empire Mill and Mining Company of New York. After passing through a short period of mining excitement, followed by the failure of the Empire Company's enterprise, the district was abandoned, three or four years later, by all but a few ever hopeful prospectors; and for many years after was not only unsought by mining investors, but was held in very slight esteem by them as a field for adventure. In 1872 some very rich gold ore was struck in the old Bullion location, and work was prosecuted on this claim, in a small way, for several years, by its owners who milled their ore in arrastras put up in Rough Creek, four or five miles northwest of the town. In 1876 this mine was purchased by San Francisco capitalits; and, with its associated claims, became afterwards the celebrated Standard mine.

The rapid success attending the operations of the Standard Mining Company was shortly after followed, early in 1878, namely, by the discovery of exceedingly rich auriferous quartz in the extensions of two of the Standard veins found in the Bodie mine, adjoining the former on the south. Miners and mining adventurers rushed in from everywhere, and hope and excitement ran high. In 1878 and 1879 the population of Bodie and its immediate vicinity was variously estimated at from seven thousand to nine thousand souls. In the latter year, following a reaction from the excitement caused by the second rich "strike" in the Bodie mine, a period of slow decline set in. The temporary suspension of dividends by the Bodie Company, in the latter half of 1880, gave a new impetus to the exodus, which was still further hastened, at the close of 1882, by the failure of the Noonday and Red Cloud companies; so that, by January, 1883, all but the larger mines had stopped work, and the population of the town had become reduced to about two thousand five hundred. Early in 1884 the Standard Company's dividends were interrupted, though the Bodie dividends were resumed, and for a few months thereafter were regularly paid. By this time, however, not more than half a dozen mines were working. Necessity compelled and other fields invited the rapidly lessening population to tempt fortune elsewhere. At the present time (September, 1888) in the once populous town of Bodie there are not more than five hundred inhabitants. And whereas, in 1879–81 there were between forty and fifty mines in active operation, there are now but three; and of these only one is extracting and milling ore, the Standard, namely.

The lodes of the Bodie District are gold and silver-bearing quartz veins in later hornblende andesite,* of which there appears to have been a succession of outflows. No determination has yet been made as to the respective ages of these successive andesitic eruptions; but judging by certain contact phenomena, observed in the Syndicate, and by others reported as occurring in the Defiance mine, it seems probable that the rock in which the Bodie veins are found is one of, if not the, oldest among them; and its high, plateau-like ridge, rises island-like in their midst. The Bodie eruptives present, macroscopically, a very great variety in appearance, from coarse, trachytic-looking masses to a brownish-black, compact rock of

*This classification of the Bodie eruptives has been made, so Mr. G. F. Becker informs the writer, in the petrographical laboratory of the United States Geological Survey, from a suite of those rocks collected by a member of its geological corps, and microscopically determined.

basaltic habit; and in earlier reports on this district they have been severally described as trachyte, trachytic porphyry, quartz porphyry, rhyolite, propylite, and basalt.

This whole region, and for many miles around, has evidently been one of great dynamic disturbance and eruptive activity during the later Tertiary and post-Tertiary period.

At its northern end, where it is cut by Bodie Cañon, which there turns abruptly to the eastward, the Bodie ridge rises in Bodie Bluff by a steep slope to an altitude of eight thousand nine hundred and fourteen feet above sea level; thence falling gently away to the south, the lowest point of the crest curve is reached where the Mono hoisting works stand just east of, and about one hundred and sixty-five feet above, the town. From there the curve ascends gradually, with an intermediate and minor flexure in Silver Hill, to its next greatest height in Queen Bee Hill, eight thousand six hundred and thirty-six feet above sea level. The range, of which in the topography of the country, the Bodie plateau forms only a subordinate part, falls away on the south to the Mono Lake Basin, and on the north to the valley of the East Walker River; and it is separated from the Sierra Nevada on the west by the Bridgeport meadows.

The hornblende andesite inclosing the Bodie veins is of a light green color and porphyritic with feldspar in very small crystals; it shows "plagoclase, apparently some orthoclase, accompanied by mica and a little hornblende. The ground mass also contains quartz."* Even in the freshest hand specimens obtained, it is evident from the occurrence of chloritic minerals and the somewhat dull porcelain-like surface of its feldspar, that the rock has undergone considerable alteration even to the lowest depths yet reached by the mine workings. In the upper levels of some of the mines, notably in the Addenda and others on Silver Hill, a so called "white cap" is found, which has been determined as hornblende andesite, and in which the alteration of its constituent minerals has been carried very far; though generally firm where freshly cut in the mines, it rapidly becomes soft upon exposure and falls apart.

Southeast of the Lent shaft, about one thousand five hundred feet, rises a small hill of a much coarser andesite with a trachytic habit. In its weathered portions it is of a warm, purplish-gray color, with crystals of sanadine porphyritically disseminated through its microcrystalline ground mass. A similar andesite surrounds the Bodie ridge on the southwest and north, rising in Mount Biderman, about three miles west of Bodie, to an altitude of about one thousand five hundred feet above the town. Even in a hand specimen of this rock a twinning of the feldspars according to the Carlsbad law could be distinctly observed in some of the larger sanadine crystals. All of these andesitic outbursts show a distinct bedding suggestive of successive overflows; and their structural planes, where observed in the outcrop of that rock east of the Lent shaft, have a trend to the northeast, with a dip to the southeast of about 60 degrees. In consequence of this structure the rock readily quarries into large blocks of from a few inches to two and three feet in thickness, and has been used in the engine foundations at several of the shafts.

Just east of the Defiance shaft house, and about two thousand feet southeast of the Lent shaft, is a bold outcrop of a handsome, fresh, basaltic-looking andesite, brownish-black in color, with a compact ground mass, in which float minute feldspar crystals. The shaft of the J. & K. mine, now

*Geological sketch of the Pacific Division, by G. F. Becker, in the United States Tenth Census Report, page 15.

called the Charleston, is sunk in this rock, as are also the workings of the Defiance; and in the latter mine the vein is reported to occur along the contact between this and the older (?) andesite, the one of basaltic habit forming its east wall.

Covering the surface of the Bodie ridge to a greater or less depth, a volcanic breccia is met with, which has a strong outcrop on Silver Hill, south of the Mono shaft; elsewhere it is generally hidden by the soil and by shallow placer deposits arising from the degradation of the rock and vein in its immediate neighborhood.

This placer deposit extends along both flanks of the Bodie ridge, and has been worked from time to time in a very small way. It is made up chiefly of angular fragments of andesite and the characteristic chalcedonic quartz of the upper portions of the Bodie veins; and its derivation from these veins by modern erosion of their neighboring croppings is further shown in the striking correspondence in value of the placer gold taken from a given locality with that of the gold from the lodes occurring closest to it on the hill. For instance, in that portion of these placers lying close to and upon the surface of the Standard and Bodie mines the gold is found to be worth from $12 to $15 per ounce, while in the placers south of this, and east of the Oro, Red Cloud, and Noonday mines, its value is reported to have been as low as $3, and rarely to have exceeded $8 per ounce. These placers are shallow, varying from a few inches to seven feet in depth; but the average depth where exposed is hardly more than two feet. No distinct auriferous channel is noticeable in them. They yield colors almost everywhere by panning; but the best pay dirt lies in spots, with much unprofitable gravel between them.

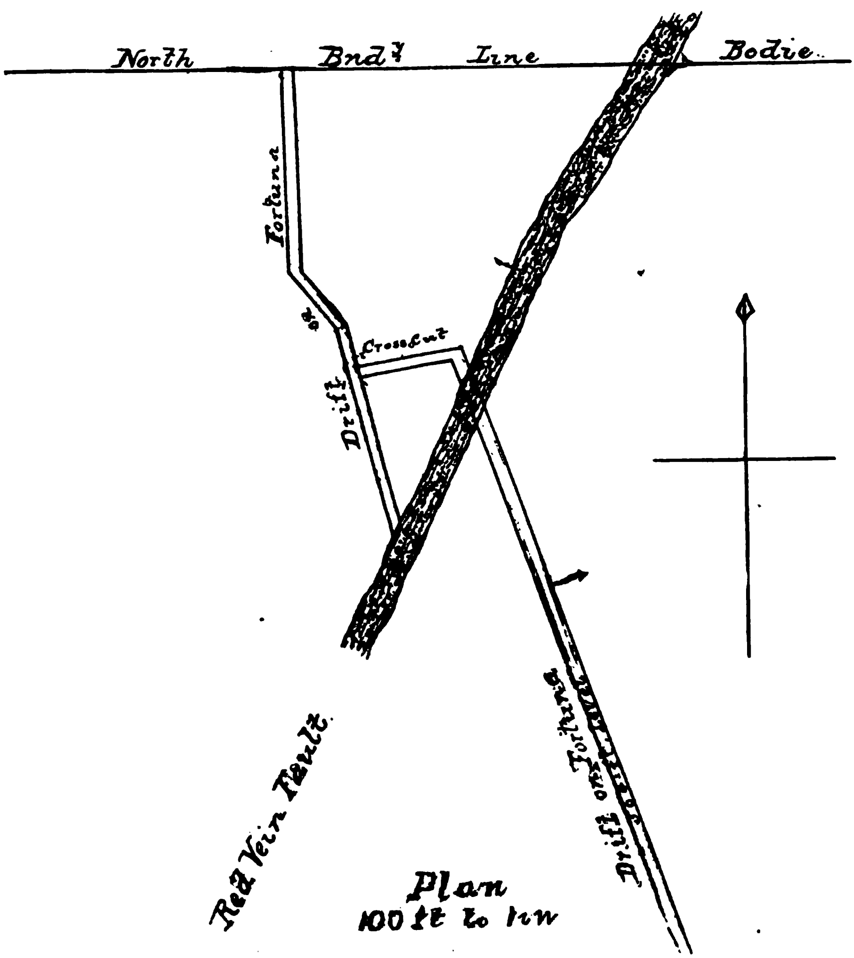
The Syndicate tunnel, on the north flank of the Bodie ridge, cuts through some two hundred feet or more of a volcanic breccia before reaching the andesite in which the veins are found; and the shafts of many of the mines have gone through from ten to fifty feet and more of the same rock, which, in every instance, was found very much decomposed and softened. At the Lent shaft, east of and between the Bodie and Mono shafts, and at about the lowest part of the crest curve of the ridge, this breccia was only eight feet thick. It was of a yellowish-gray color, very much altered, and containing angular fragments of andesite and of the quartz peculiar to the gold veins of the Standard series.

In consequence of this superficial covering, but few of the veins of the Bodie District have any outcrop; most of them being what the miners term "blind leads." As the ore bodies are stoped upward from below, they divide into numerous spreading veinlets and seams upon nearing the horizon at which the breccia overlies the andesite, and they give out abruptly when that contact is reached.

As indicating the probable channels through which this later, andesitic breccia may have found its way to the surface, the presence of several cross-cutting intrusive bodies or dikes reached in the Standard, Bodie, and Mono workings, is significant. The ground mass of these dikes, where they are encountered, is now so wholly decomposed and altered into clays, that its original constitution cannot be determined; but, distributed irregularly through the matrix, are angular and rounded fragments of older eruptive rocks, themselves usually very much altered. The so called Red Vein in the Bodie mine is such a dike, so named from its bright red color, due to abundant presence of hematite arising from the oxidization of pyrite, with which the material of the dike must originally have been highly charged. This vein or dike has been cut in at least six places in the Bodie workings, where its width is from six to ten feet. Its strike is about north 20 degrees

east, and its dip northwest about 85 degrees. It faults the older Fortuna vein by a right-inclined throw, whose vertical height at one place, namely, at the fourth incline level, is twenty-two feet, and at the sixth incline level, and about one hundred and twenty feet north, is twenty-six feet. (Plates I and II.)

PLATE II.



In the Lent shaft, at a depth of six hundred and fifty feet, and just below the Fortuna, another and larger vein or dike, of what seems to have been a volcanic breccia, was also cut. This faults the Fortuna vein west of the shaft above the six hundred-foot level, by a throw to the east, whose hade makes, with the inclination of the Fortuna, an obtuse angle of about 160 degrees. The vertical height of this throw is not less than fifty feet.

The Standard vertical shaft is said, by those who watched its sinking, to have passed from the surface down to the depth of about one hundred feet, through what is described as "a wide channel filled with bowlders and clay, and looking something like the gravel in the bed of the creek, only the bowlders were not round." This is presumably the much decomposed

and altered representative of a similar dike but one of great width. The probable west wall of this same dike is reported by the former Superintendent of the Bulwer mine to have been cut by him at the one hundred-foot level of that mine, in an east crosscut from the Bulwer shaft. This wall is described as dipping eastward at an angle of about 50 degrees; and its surface was marked by slickensides and striations; its strike was northeasterly, and about parallel with that of the Bulwer veins. On this wall lay a wide zone of clay, bowlders, quartz, and country rock, through which the crosscut was driven forty feet without reaching its east wall.

The strike of these dikes is generally from north to north 20 degrees east, magnetic; and, with few exceptions, they dip westwardly at high angles. Such as dip eastwardly, moreover, are perhaps instances of a local change of direction, such as is frequently met with both in the dip and strike of most fissures. As is usually the case with such crosscutting bodies of eruptive rock, these dikes are water-bearing, thus adding greatly to the expense of mining in this district.

With respect to their genesis, the quartz lodes of Bodie District arrange themselves in at least two groups, differing noticeably in the character of their mineral constituents, and owing their origin as fissures to at least two dynamic movements, separated by what was doubtless a long interval of time. As between the correlated members of each group, there is observable a general parallelism of the fault fissures, both in strike and dip, in both of which respects the fissure planes of the one group make a wide angle with those of the other. The veins of that, which for convenience may be here called the Standard series, fault the older series, whose most productive representative has been the Fortuna vein in the Bodie mine; and in this latter mine the relations between the two groups are seen to best advantage. There is structural evidence in the extensive sheeting of the wall rocks in directions generally parallel with that of the fissures, as also in the presence of slickenside surfaces, striations, and much brecciated material, cemented by the quartz-filling in the lodes themselves, going to show that the veins of both groups were produced by fault movements in the rock mass, in relief, perhaps, of the tension consequent upon great lateral compression, and as such they belong to the class designated as fault fissures (*Spaltenverwerfungen*). Even in the minuter structure of the rock this effect of compression is no less strikingly evidenced by a schistose foliation along now one, now the other, wall of a fissure; and, as a peculiar feature of these ore bodies, such foliated portions have invariably been found to be very rich both in gold and silver; as though this structure, originally due to compression, had offered in the innumerable, though minute, fault fissures thus formed, such retardation to the flow of the mineral bearing solutions and such virtual increase of deposition surface as to have caused a more abundant mineralization of the veins at such localities.

The younger series of lodes, as illustrated in the several veins of the Syndicate, Bechtel, Standard, and Bulwer mines on the north, follow in general those structural planes of the andesite which apparently have some dynamic relation with the series of dikes before described. Such veins were most productive in the southern half of the Standard mine, and the extensions of two of them were exceedingly rich in the Bodie mine for one hundred and fifty feet or less south of the Standard-Bodie boundary. A very general parallelism is observable between these lodes and the dikes both in dip and in strike,—their strike being north to north 20 degrees east, their dip, westward, at from 35 degrees to 85 degrees. The entire distance between two such parallel veins is often found very much shattered; and portions of the wall rock, locally called "porphyry," is in such places of

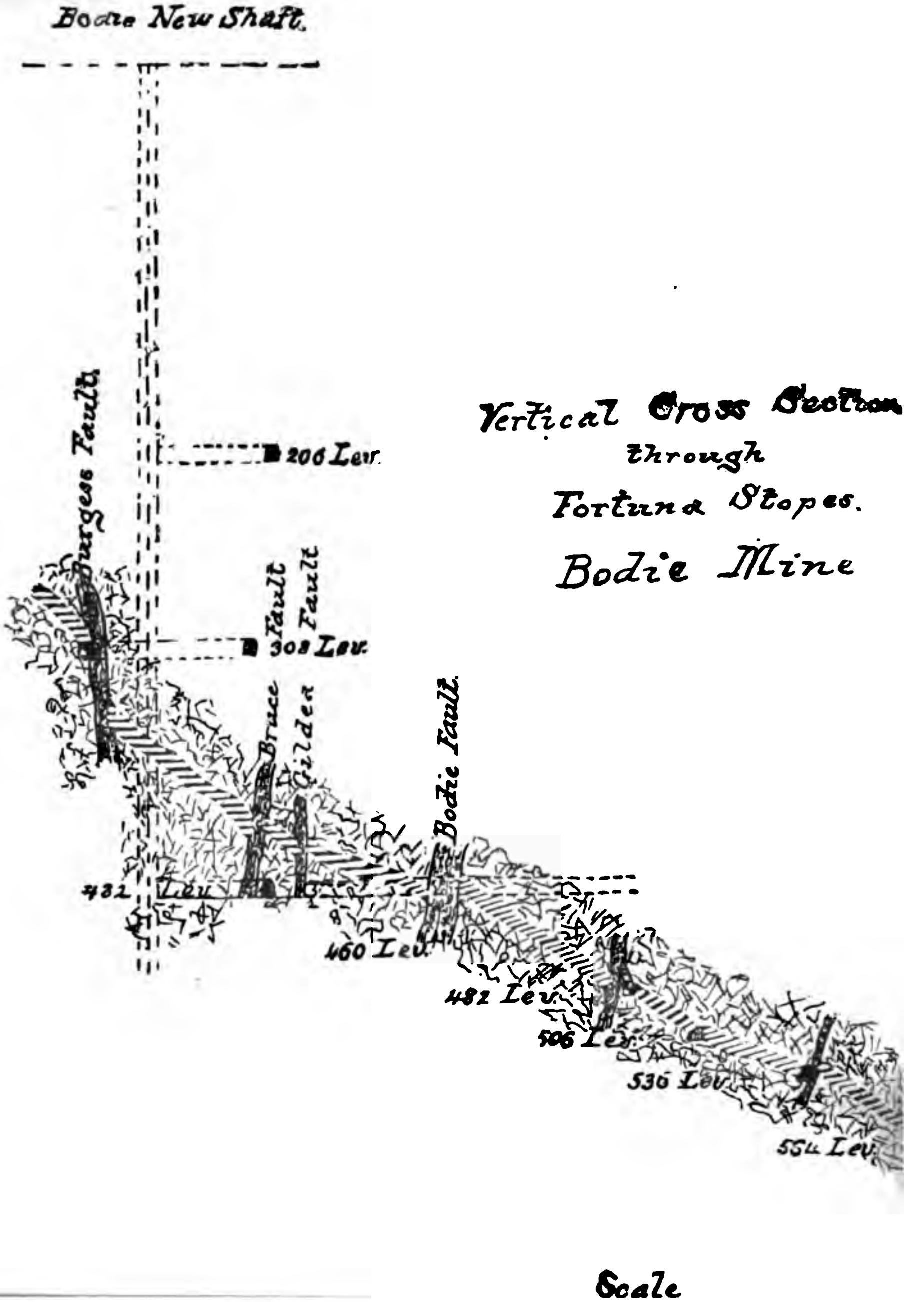
shattering generally found to have been so much mineralized to the depth of several feet on one or the other, sometimes on both, sides of the fissure, as richly to repay extraction.

The Bodie ore deposits, both in the older and younger series of lodes, seem to have been in part a filling of open fissures, in part a gradual replacement of thinly-sheeted country rock between the principal structural planes of fractured zones, by the vein-forming minerals once held in solution. In the ore bodies themselves there is the same sheeting of the quartz, in very many instances, as is observable in the inclosing rock, giving it in places a sort of banded structure which is particularly well developed in the veins outcropping in Bodie Bluff; and the veinstone frequently contains angular fragments of andesite, around which the quartz and ore minerals are deposited in a firmly cohering layer completely surrounding them. In some places the quartz is saccharoidal, as though it had been crushed and comminuted by later movements in the rock mass. This latter characteristic is more marked in certain veins, as in the Main Standard and Gildea, than in others, and is more often found in the larger than in the smaller fault-fissures.

Not only have these younger lodes their largest development in the Standard mine, but they have there been the most productive. North of that they are more numerous, but smaller, as though the dynamic force to which they owe their origin had had its energy dissipated along many lines as it approached that limit of its action. In the Syndicate mine, on the extreme north end of the mineral belt, the veins became unproductive at a horizon about fifty feet below the lower Osceola tunnel; or, about two hundred and fifty feet below their croppings on Bodie Bluff. This mine has been thoroughly prospected east and west at two localities, over its whole width of one thousand two hundred feet, by crosscuts from the Syndicate tunnel, which is five hundred feet below the Osceola tunnel. Numerous small veins of quartz are met with in these crosscuts, but they are all barren of ore, or so nearly so as not to repay extraction. There is observable here, however, an arrangement of the veins on either side of a vertical plane drawn northward and southward through the Syndicate tunnel: those on the west of that tunnel dipping eastward; those on the east dipping westward, and, generally, at high angles. So little work has been done below this tunnel that the relations of these opposite dipping lodes is as yet undetermined. They may unite in depth into one vein, as was suggested by the late Professor Silliman, and by Professor W. P. Blake; but their distance apart on this level is so great that such junction, if it exists, will only be found at a very considerable depth below the Syndicate tunnel level. In these veins the banded structure is more characteristically developed than elsewhere in the district.

In the Bodie mine two members only of the Standard series were productive, namely, the Burgess and Bruce veins, which are, respectively, continuations southward of the Cook and Bruce veins of the Standard mine; but their productive portions ceased at something less than one hundred and fifty feet south of the boundary line between the two mines. These lodes were followed several hundred feet beyond their impoverishment, but there was no quartz filling, the vein being represented only by a fissured and barren zone in the andesite.

These Standard ore bodies, as will be seen by reference to Table I, page 396, have produced a little over 59 per cent of the entire bullion yielded by the district since 1877. They became unproductive, however, below the five hundred-foot level of the Standard mine, as they did at a corresponding horizon in the Bodie, namely, at a little below its three hundred-foot


Bodie New Shaft.
Burgess Fault
206 Lev.
Bruce Fault
Gilden Fault
308 Lev.
Bodie Fault
432 Lev.
460 Lev.
482 Lev.
506 Lev.
536 Lev.
554 Lev.
Vertical Cross Section
through
Fortuna Stopes.
Bodie Mine
Scale


Vein
60 Lev.

level. The main Standard vein was the largest though not the richest ore carrier of the younger series; and had at one place, on the three hundred and eighty-five foot level of that mine a width of ninety feet; its average width, however, in the different workings was about twenty feet. Its dip was about 40 degrees westward, or at a considerably lower angle than was the case with most of the other veins of that series, which were from two to six feet wide, with a westward dip of from 65 to 80 degrees. In the long cross-cuts at the seven hundred, one thousand, and twelve hundred foot-levels of the Standard, these younger fault-fissures are represented only by numerous small veins of nearly barren quartz, and, perhaps, by certain zones of thinly sheeted country rock there found.

In all of these younger series of lodes the gold content largely exceeds in value that of the silver, though in the relative proportions of the two metals by weight, the silver is somewhat in excess of the gold tenure. In the average assay value of the Standard ore, as given in its Superintendent's report for the fiscal year ending February 1, 1883, the gold content was stated at $34 28 per ton, the silver at $4 07, in a total of $38 35 per ton of two thousand pounds. Its silver value was calculated at $1.2929 per troy ounce, the gold at $20.6718 per ounce. In weights, therefore, the average gold contents of the ore for the year were 1.65 troy ounces per ton; while the silver tenure amounted to 3.14 ounces per ton, forming 65.6 per cent, by weight, of the precious metals in the ore of these so called gold mines. The native gold of these Bodie veins, moreover, is itself an alloy with silver in the proportion of about six hundred and seventy-five thousandths gold and three hundred and five thousandths silver. Apart from this occurrence of the silver, however, these veins also carry that metal in flakes and wires, and mineralized as argentite and kerargyrite. In addition to the precious metal contents, the other mineral associations are magnetite and a mixture of earthy oxides of iron and manganese, together with more or less pyrite. This magnetite is in such amount in these younger lodes, and especially in the Bechtel, Bodie Tunnel, and several of the Standard veins, as to have occasioned considerable losses in the milling of their ores. It has itself resulted from a higher oxidation of auriferous pyrite, and is rich in gold; but, up to the present time, it has yielded only a small percentage, if any at all, of its precious metal contents, under the methods heretofore employed.

Quartz, with some calcite, and occasionally gypsum, constitute the chief gangue material of the veins; but calcite is present in much larger quantities in the Noonday and other veins in the southern portion of the belt than in the Bodie or Standard.

The older series of lodes is represented in the Fortuna of the Bodie mine and, probably, in the east dipping veins of the Addenda, Paris, Concordia, Noonday, Red Cloud, and other mines along the central and more southern portions of the Bodie belt. These veins have a higher tenure in silver, as compared with that in gold, than the younger series just described; and they all of them show, moreover, a noticeable decrease in the relative proportions of the more valuable content as depth on them is gained. Structurally, however, they are of the same type as the younger lodes. These older lodes have a prevailing strike somewhat west of north, and they dip eastward at from 30 degrees to 50 degrees. Only the Standard, Bulwer, and Bodie mines were working at the date of this visit, and no examination could be made of the veins lying south of the Lent shaft, from Silver Hill to Queen Bee Hill: so that the writer's knowledge respecting the veins of this series other than the Fortuna, is confined to such as was gained in a brief inspection of several of them in 1882, in the workings of

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The older series of lodes is represented in the Fortuna of the Bodie mine and, probably, in the east dipping veins of the Addenda, Paris, Concordia, Noonday, Red Cloud, and other mines along the central and more southern portions of the Bodie belt. These veins have a higher tenure in silver, as compared with that in gold, than the younger series just described; and they all of them show, moreover, a noticeable decrease in the relative proportions of the more valuable content as depth on them is gained. Structurally, however, they are of the same type as the younger lodes. These older lodes have a prevailing strike somewhat west of north, and they dip eastward at from 30 degrees to 50 degrees. Only the Standard, Bulwer, and Bodie mines were working at the date of this visit, and no examination could be made of the veins lying south of the Lent shaft, from Silver Hill to Queen Bee Hill: so that the writer's knowledge respecting the veins of this series other than the Fortuna, is confined to such as was gained in a brief inspection of several of them in 1882, in the workings of

stopes on the so-named Rich Vein, below the six hundred and seventy-foot incline level of the Bodie mine, a few crystals of pyrargyrite were met with,—the only occurrence of this mineral, however, ever noticed in this mine. In the veins of the Oro, Addenda, and other mines south of the Bodie, stephanite and pyrargyrite were noticeably abundant in addition to the other minerals mentioned above; and these antimonial silver sulphides are reported as having been found in the Fortuna vein further south, in the Mono workings, where the neighborhood of Silver Hill is approached.

A singularly abrupt termination of the bonanza in the Fortuna itself, occurred at a horizon just below the six hundred and one-foot (or sixth incline) level, such as calls for a brief description. In a winze sunk from that level, and twenty-three feet below it, a very narrow vein left the foot-wall of the Fortuna at a high angle (see Plate I). This smaller vein, varying from one inch to one foot in width, seems to have produced no noticeable movement of displacement in, though it intersected, the Fortuna; and, in the hanging-wall of the latter vein, it was represented by a mere plane of parting in the rock. In its strike and dip, so far as explored, this rich vein observed a general parallelism with the Red Vein heretofore described, from which it is distant horizontally about one hundred feet to the east. This latter ore channel seemed simply to drop abruptly from the foot-wall of the Fortuna, of whose bonanza it formed virtually the continuation, inasmuch as below its point of departure the Fortuna vein became almost completely impoverished and has so continued throughout the several hundred feet to which it has been explored below this. As is the case along all of the Bodie fault-fissures the andesite on either wall of the rich vein is more or less thinly sheeted, and, along such structural planes, to the depth of a foot or more from this narrow quartz vein, native silver was often found in the wall-rock, in small fronds and wires; so that where the quartz of the vein did not exceed six inches in width, from eighteen inches to two feet could often be profitably mined. Below the seven hundred and eighty-four-foot (Lent shaft, seven hundred and seven-foot) level, this small vein broke up into seams and veinlets of low grade quartz and was not mined below that horizon. Its ore body, however, is included in the statement respecting the depth of the Fortuna bonanza, having been considered a part thereof.

In the workings from the Lent shaft, sunk jointly by the Bodie and Mono companies, and one thousand feet east of their old shafts, the Fortuna vein is seen again at several horizons below the six hundred and forty-four-foot level, where that shaft cut it. At such places it has been recovered by crosscuts, after a series of faultings, in some of which the vertical throw cannot be less than fifty feet. It is reported by the Bodie Superintendent to have been found again at the twelve hundred-foot level of the Lent shaft. In all these places the Fortuna fissure preserved its characteristic direction in strike and dip, although the latter takes a much higher angle than it does in the upper levels. In these lower workings, however, the Fortuna is found to carry quartz only in small, isolated bunches and veinlets, which are occasionally rich in precious metals, but are insignificant in extent. The fissure, however, is represented at all of these horizons by thin, parallel sheets of very much altered rock and clays, charged with crystalline pyrite, and showing the polished, striated surfaces suggestive of extreme compression and rock movement.

Present interest in Bodie District and hope in its future are centered in the work now doing through the Lent shaft at its deepest levels. Although the Standard Company is still extracting and milling a fair quality of ore from the old workings above its five hundred-foot level, and the Bulwer

Company is carrying on a little prospecting work in its upper levels, neither of these two companies is prosecuting any exploration work in depth.

Through the courtesy of the editor and proprietor of the "Mono Relief," published in Bodie, a memorandum was obtained from successive files of the "Daily Free Press" and "Bodie Miner," of the entire bullion output from the mines of the Bodie District from 1877 to 1886, as the same was reported yearly through Wells, Fargo & Co.'s agent at Bodie. These data, completed to October 1, 1888, through the kindness of their present agent, are given in Table I, pages 396, 397; together with those relating to dividends and assessments.* An effort was made to render this table more complete by giving separate yields for each mine in gold and silver; but this was found to be impracticable in consequence of the removal of certain of the older books of record from Bodie. Table II, however, gives an estimate of the proportionate yield in each metal for the years 1879 to 1882, inclusive, as the same was reported in the "Bodie Free Press" of January 4, 1883; and as the data in this table have been arranged in the order in which the mines themselves occur from north to south on the belt, they will serve to illustrate in a general way the relative decrease in gold and increase in silver tenure in these mines as they follow one another in that direction from Bodie Bluff. In this table are also given the percentage weights of the two metals in the product from each mine for the same years, obtained by a calculation entirely analagous to that given for the Standard ore on page 389. From this second division of the table the relative tenures of the Bodie ores in silver and gold can be seen in their true proportions.

On pages 399–401 will be found a synoptic table (III), showing for three consecutive years the average values, annually, of the ore from the Bodie mine, with other statistics of interest. During each of these years, in the case of that mine, such statistics were carefully gathered and recorded. The ore milled in those three years was mined principally from the Fortuna vein, and a gradual decrease in its relative gold tenure and increase in the silver tenure as depth on that vein was gained, is noticeable. The real variation in this respect, however, was greater than is apparent, the figures being somewhat distorted in consequence of the milling of a considerable amount of ore from the old stopes of the Bruce and Burgess gold veins with that from the Fortuna. An unsuccessful effort was made to obtain a similar series of statistics from all of the heretofore productive mines of the district.

Of the mining operations of, and the shipments of bullion made by, the Empire Mining and Milling Company, owning what is now the Syndicate Mine, from 1863 to 1866, and of the bullion produced, in a small way, from other mines, whose ores were worked in arrastras by prospectors, in the earlier history of the district, no record could be obtained; nor was it found possible to secure from any authentic source, figures that would justify any estimate respecting the output from Bodie District prior to 1877.

Two or three white men and as many Chinamen are at present engaged in mining the auriferous surface deposits eastward of the Lent shaft, employing for this purpose the water taken from that mine. Of the product from these placers no satisfactory estimate could be obtained; it is included, however, in Table I, with that from many other sources, in the shipments made from time to time by the Bodie banks and other parties; but no

* Taken from files of the "Engineering and Mining Journal," the published lists of the "Mining Stock Record" of San Francisco, "United States Tenth Census Report," and "Mines, Miners, and Mining Interests of the United States," 1882. The dates so obtained have been verified in a number of instances, and wherever the official records of the several mining companies could be reached, by information received from their respective Secretaries, whose courtesies in the premises are hereby acknowledged.

memorandum seems to have been kept as to the particular source of the bullion in any instance.

Of the ten quartz mills in the Bodie District, aggregating one hundred and sixty-two stamps, only fifteen stamps have been in operation during the past year, namely, those of the Standard Company's one half of the Bulwer-Standard Mill. On the first of August, of the present year, this mill was stopped for repairs; but it was expected that milling would be resumed by the first of October following. In the Bulwer-Standard Mill the ore is charged by automatic feeders into double discharge mortars, where it is crushed by stamps weighing eight hundred and fifty pounds each, set at six and one half inches, and wearing to eight and one half inches of drop. The stamps are speeded to about ninety drops per minute; the average duty of the battery is three tons of ore per stamp-head, per twenty-four hours. The ore is discharged from the mortars through steel wire screens of thirty meshes to the linear inch. The pulp is amalgamated raw in twelve cast iron pans of the usual form, heated by steam to about 160 degrees Fahrenheit. The only chemicals used besides quicksilver are crude "soda" from the marshes of Mono Basin, and a little quicklime; and these only for the purpose of keeping the quicksilver clean. With one ton of ore (dry weight) are charged ten pounds of crude "soda," and fifty pounds to seventy-five pounds of quicksilver, for ores assaying from $15 to $25 per ton. The pans are run on six-hour charges, giving four charges per day of twenty-four hours; from which it will be seen that the pans crowd the battery a little. The weight of ore, as in most instances throughout the quartz mills of this country, is not arrived at directly, but is estimated from the number of carloads. In the case of the Standard Mill, the carloads are credited with an average capacity of three thousand pounds of ore each—a figure arrived at as the average of many weighings of the loaded cars.

No regular system of concentration of the tailings has heretofore been employed in any of the Bodie mills, although in several instances experiments have been made in that direction. At the Bulwer-Standard Mill the tailings from the settlers and agitators are at present passed over blanket sluices; and these very imperfect concentrations are, after sufficient of them have been collected, subjected to a simple oxidizing roasting in a small single-hearth reverberatory, about ten feet long by six feet wide, with a capacity of one thousand six hundred to two thousand pounds per day of twenty-four hours. The roasted product is afterwards charged in pans with the ore. This operation is as yet only in the experimental stage, the attempt to save the heretofore neglected tailings having only recently been undertaken by this company.

Figures as to the cost of mining and milling were not obtainable. It is thought not to exceed $9 per ton of ore in the case of the Standard Company at present. Up to August first, of the present year, that company employed on an average fifty-eight men at the mine and mill and on outside work. The wages of miners were $4 per day, that of mechanics and engineers $5, battery feeders and amalgamators $4, pan men, blanket tenders, and general laborers, $3 50 per day. The cost of fuel is $10 per cord delivered at the mine. Mining timber and lumber cost $35 per thousand, as supplied by the Bodie and Benton Railroad and Commercial Company.

From the foregoing report it will be seen that this comparatively little known mining county of California has produced not less than $24,205,792, of which $18,097,922 was the product, since 1877, from the Bodie District. Of the bullion produced prior to that time, with the exception of that coming from the Benton Districts, no satisfactory account could be obtained.

The above sum therefore does not include the output from the Mono Diggings from 1857, when they were first discovered, up to 1882, when the Virginia Creek Hydraulic Mining Company came into possession of the old mining ground and began its operations thereon. Nor does it take account of the output from the Bodie mines prior to 1887, of which, notwithstanding every effort, no authentic information could be had. Moreover, there are several old districts in the county wherein not even so called prospecting operations have been carried on for many years; but from which some few ores and perhaps a little bullion were once shipped. Such are, for instance, the old Leavitt District, about five miles north of Leavitts Station, on the Sonora road; and another on Silver Creek, about thirty miles northwest of Bridgeport. To cover the output from all such and other unknown sources combined, it would probably be much within bounds to add $2,000,000 to the above estimate of the Mono County mineral product.

Notwithstanding the present dullness in the condition of the mining industry of this county, and by no means peculiar to it, the observer could not examine even hurriedly its several mineral districts without carrying away with him the impression that not a few of the failures in its mining ventures should, as in so many instances elsewhere, be charged to other factors than those legitimately concerned in the mining problem. In nearly every one of the districts visited mines were found lying idle or, in some instances, being worked in a small way by a few miners under leases, that could probably be made remunerative, and doubtless will one day become so under systems better adapted, perhaps, to the conditions prevailing, and by the application of improved mining and metallurgical methods. Even as it is, not a few failures can very clearly be laid to the door of excessive capitalization and stock jobbery, and to the extravagance and often incompetent and corrupt management which such factors so naturally bring in their train.

In view of the great number and interesting character of its vein systems, and of the fact that many of its known mineral deposits are far from having become exhausted, while others will doubtless yet be discovered, it is to be hoped that a renewed and healthier activity in its mining industry is before this county.

TABLE I.

Total Bullion Shipments from Bodie Mines, from 1877 to 1888, with Dividends and Assessments for same Period.

Mines.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
Syndicate			$12,316 38	$24,769 75	$134,706 30	$75,458 29	$92,039 96
Summit*	$1,500 00						
McClinton†							
Bechtel Consolidated		$61,030 17	11,345 50		123,751 89		
New Standard							
Bodie Tunnel					10,626 81	129,216 53	51,742 50
Sitting Bull			3,485 09				
Mexican	2,000 00						
Standard Consolidated	784,522 80	1,025,383 35	1,448,845 47	1,858,763 46	2,168,575 63	1,258,056 80	1,155,181 83
Bulwer			241,094 38	117,498 33			
Consolidated Pacific							
Belvidere				25,901 26			
Bodie Consolidated		1,042,236 80	784,057 12	429,817 80	372,800 50	484,890 48	246,820 10
Mono							
Dudley				1,746 06			
Oro					14,155 66		
Concordia					5,670 38		
Red Cloud	10,927 50						
Noonday and North Noonday			36,532 29	511,757 21	244,000 00	231,000 00	
Boston Consolidated						1,331 00	
Wagner's Tailings Mill						8,300 00	
Shipments by banks, and scattering shipments‡		1,550 00	132,445 26		85,780 34	29,527 14	36,882 69
Totals	$798,950 30	$2,130,200 32	$2,670,121 49	$2,970,253 87	$3,160,067 51	$2,217,780 24	$1,582,667 08

TABLE I—Continued.

Mines.	1884.	1885.	1886.	1887.	1888.	Totals.	Total Dividends.	Total Assessments.
Syndicate	$155,244 36	$90,176 17				$584,711 21	$48,308 00	$38,728 75
Summit*						1,500 00		117,500 00
McClinton†				$1,064 69		1,064 69		123,000 00
Bechtel Consolidated						196,127 56		260,000 00
New Standard	17,714 76					17,714 76		
Bodie Tunnel	2,075 90	5,909 46	$20,233 52			219,804 72		201,000 00
Sitting Bull						3,485 09		
Mexican						2,000 00		
Standard Consolidated	304,294 76	214,561 22	228,084 76	287,554 68	$118,371 25	10,852,196 01	4,495,000 00	25,000 00
Bulwer			70,144 06	16,101 50		444,838 27	175,000 00	110,000 00
Consolidated Pacific			1,530 52			1,530 52		177,000 00
Belvidere						25,901 26		222,000 00
Bodie Consolidated	618,024 18	48,632 72	19,463 63	19,185 55		4,065,928 88	1,602,572 00	524,990 00
Mono		5,975 77	116,392 26			122,368 03	12,500 00	685,000 00
Dudley						1,746 06		198,400 00
Oro						14,155 66		100,000 00
Concordia						5,670 38		45,000 00
Red Cloud						10,927 50		155,000 00
Noonday and North Noonday						1,023,289 50		208,000 00
Boston Consolidated						1,331 00		120,000 00
Wagner's Tailings Mill	17,600 00	24,600 61				50,500 61		
Shipments by banks, and scattering shipments‡	8,630 00	59,910 00	70,606 40	17,875 61	7,923 66	451,131 10		
Totals	$1,123,583 96	$449,765 95	$526,455 15	$341,782 03	$126,294 91	$18,097,922 81	$6,333,380 00	$3,310,618 75

* Formerly Kate Rogers Mine, when bullion was shipped.

† Now called Midnight Mine.

‡ Included in these amounts are bullion and gold dust from Bodie placers; that bought from Indians and obtained from picking over the mine dumps; product from Wagner's Tailings Mill in 1880 and 1881; placer gold from Dogtown Diggings, some from Mono Diggings and other outlying placers near Bodie; small amounts of bullion from Lundy, Mammoth, Keith, and Patterson Districts, not elsewhere accounted for; and a few other sources not reported. No separate account of the amount from each of the above sources could be obtained.

NOTE.—Only the assessments levied by mines that, in however small degree, were bullion producers, are given in the above table. Besides these there were about thirty other Bodie mines, all more or less actively working between 1878 and 1881, which levied assessments in that period aggregating about two and a quarter millions of dollars.

TABLE II.

Gold and Silver Percentages in Bullion Product from Bodie Mines.

Mines.	Percentage Values.*								Percentage Weights.							
	1879.		1880.		1881.		1882.		1879.		1880.		1881.		1882.	
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
Syndicate	33.0	7.0	89.0	11.0	89.0	11.0	91.4	8.6	45.3	54 7	33.8	66.2	33.8	66.2	39.8	60.2
Bechtel Consolidated					98.5	1.5							80.4	19.6		
Bodie Tunnel							93.4	6.6							46.8	53.2
Sitting Bull	90.0	10.0							36.0	64.0						
Standard Consolidated	92.0	8.0	93.0	7.0	91.4	8.6	89.8	10.2	41.8	58.2	45.3	54.7	39.8	60.2	35.4	64.6
Bulwer Consolidated	92.0	8.0	93.0	7.0					41.8	58.2	45.3	54.7				
Bodie Consolidated	85.0	15.0	59 5	40.5	68.6	31.4	54.8	45.2	26.1	73.9	8.4	91.6	11.9	88.1	7.0	93.0
Belvidere			37.0	63.0							26.8	73.2				
Dudley			30.0	70.0							21.1	78.9				
North Noonday			40.6	59.4	57.7	42.3	56.0	44.0			4.0	96.0	7.8	92.2	7.3	92.7
Noonday	70.0	30.0	78.5	21.5	74.0	26.0	60.0	40.0	12.7	87.3	18.5	81.5	15.2	84.8	8.6	91.4
Concordia					8.5	91.5							.6	99.4		
Boston Consolidated							86.0	14.0							27.7	72.3
Wagner's Tailings Mill†							50.0	50.0							5.8	94.2

* This portion of Table II is taken from the Bodie "Daily Free Press" of January 4, 1883, and was calculated from bullion returns of the several mines as the same were reported by Wells, Fargo & Co.'s agent at Bodie. In all of these values gold was calculated at $20.6718 per troy ounce, and silver at $1.2929.

† This product was chiefly from a reworking of the tailings from the Standard and Bulwer-Standard Mills.

TABLE III.*

Ore and Bullion Statistics, Bodie Consolidated Mining Company.

	1881.†											
	Ore.						Percentage Results.			Bullion.		
	Gold. Ounces.	Silver. Ounces.	Total Ounces.	Gold Value.	Silver Value.	Total Value.	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Average assay value, per ton, of pulp from rich ores§	......	......	......	......	......	......	......	......	......	......	......	......
Average assay value, per ton, of pulp from ordinary ores	......	......	......	......	......	......	......	......	......	......	......	......
Average assay value, per ton, of pulp from all ores	1.266	30.34	31.606	$26 19	$39 23	$65 42	......	......	......	......	......	......
Average assay value, per ton, of tailings	.108	7.52	7.628	2 24	9 73	11 97	......	......	......	......	......	......
Average yield from pulp, per ton, in pans	1.158	22.82	23.978	23 95	29 50	53 45	......	......	......	......	......	......
Average yield from battery sands,‡ per ton of ore	1.096	.37	1.466	22 66	48	23 14	......	......	......	......	......	......
Average total yield from pans and battery sands, per ton of ore	2.254	23.19	25.444	46 61	29 98	76 59	......	......	......	......	......	......
Total average value of ore, per ton**	2.362	30.71	33.072	48 85	39 71	88 56	......	......	......	......	......	......
Average percentage extracted in pans	......	......	......	......	......	......	91.44	75.19	81.70	......	......	......
Average percentage extracted in pans and battery	......	......	......	......	......	......	95.41	75.24	86.49	......	......	......
Average fineness of bullion, in thousandths	......	......	......	......	......	......	......	......	......	82	823	905
Average value of bullion, per troy ounce	......	......	......	......	......	......	......	......	......	$1 66	$1 06	$2 72

TABLE III—Continued.

	1882.†											
	ORE.						PERCENTAGE RESULTS.			BULLION.		
	Gold. Ounces.	Silver. Ounces.	Total Ounces.	Gold Value.	Silver Value.	Total Value.	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Average assay value, per ton, of pulp from rich ores§												
Average assay value, per ton, of pulp from ordinary ores												
Average assay value, per ton, of pulp from all ores	1.89	24.00	25.89	$39 11	$31 03	$70 14						
Average assay value, per ton, of tailings	.11	5.80	5.91	2 28	7 50	9 78						
Average yield from pulp, per ton, in pans	1.78	18.20	19.98	36 83	23 53	60 36						
Average yield from battery sands,‡ per ton of ore	.38	.74	1.12	7 90	97	8 87						
Average total yield from pans and battery sands, per ton of ore	2.16	18.94	21.10	44 73	24 50	69 23						
Total average value of ore, per ton**	2.27	24.74	27.01	47 01	32 00	79 01						
Average percentage extracted in pans							94.17	75.83	86.06			
Average percentage extracted in pans and battery							95.15	76.56	87.62			
Average fineness of bullion, in thousandths										96.1	841.9	938
Average value of bullion, per troy ounce										$1 98	$1 09	$3 07

TABLE III—Continued.

	1883.†											
	ORE.						PERCENTAGE RESULTS.			BULLION.		
	Gold. Ounces.	Silver. Ounces.	Total Ounces.	Gold Value.	Silver Value.	Total Value.	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Average assay value, per ton, of pulp from rich ores§	9.545	269.11	278.65	$197 33	$347 94	$545 27	......	......	......	......	......	......
Average assay value, per ton, of pulp from ordinary ores	.883	23.92	24.80	18 26	30 93	49 19	......	......	......	......	......	......
Average assay value, per ton, of pulp from all ores	1.172	31.19	32.36	24 24	40 33	64 57	......	......	......	......	......	......
Average assay value, per ton, of tailings	.009	6.69	6.70	20	8 66	8 86	......	......	......	......	......	......
Average yield from pulp, per ton, in pans	1.163	24.50	25.66	24 04	31 67	55 71	......	......	......	......	......	......
Average yield from battery sands,‡ per ton of ore	.177	......	.17	3 77	......	3 77	......	......	......	......	......	......
Average total yield from pans and battery sands, per ton of ore	1.340	24.50	25.84	27 81	31 67	59 48	......	......	......	......	......	......
Total average value of ore, per ton**	1.349	31.19	32.54	28 01	40 33	68 34	......	......	......	......	......	......
Average percentage extracted in pans	......	......	......	......	......	......	99.17	78.52	86.28	......	......	......
Average percentage extracted in pans and battery	......	......	......	......	......	......	99.29	78.52	87.03	......	......	......
Average fineness of bullion, in thousandths	......	......	......	......	......	......	......	......	......	51.1	930.9	982
Average value of bullion, per troy ounce	......	......	......	......	......	......	......	......	......	$1 06	$1 20	$2 26

* In this table silver values are calculated at $1.2929 per troy ounce; gold values, at $20.6718.
† The company's fiscal year is meant, ending annually in June.
‡ Rich sands caught behind battery screens (forty meshes to one linear inch). Such sands were separately amalgamated in the clean-up pan.
§ Delivered to mill in sacks, and separately sampled and assayed.
** Sum of total average yield per ton of ore and average assay values of tailings.

MONTEREY COUNTY.

This county derives its name from the City of Monterey, formerly the capital of Alta California. The term in the Spanish language signifies Kings Mountain.

The county is bounded on the north by the Bay of Monterey and Santa Cruz County, on the northeast and east by San Benito, Fresno, and Tulare Counties, on the south by San Luis Obispo County, and on the west by the Pacific Ocean.

This county is largely occupied by ranges of mountains and spacious valleys, some of which widen out into extensive plains. Two high ridges of the Coast Range—the Santa Lucia and the Gabilan—traverse the county nearly its whole length, running parallel with the seashore. Between these two ridges is situated the Salinas Valley, containing a large area of rich farming land. To the east of the Gabilan Range lies the San Benito Valley, also a rich agricultural district. The Salinas River, the only considerable stream in the county, after flowing ninety miles north through Salinas Valley, empties into the Bay of Monterey. The Pajaro River, which separates this from Santa Cruz County, after flowing west ten miles, empties into the same bay. The soil throughout this county is generally fertile, even the mountains producing much grass. Monterey is distinguished alike as a grain and stock-raising county, and is believed to have contained, twenty years ago, more sheep than any other county in the United States. The wool clip is still very large and of fine grade. While the Santa Lucia Range is for the most part covered with valuable forests the rest of the county is rather sparsely timbered.

The Salinas Valley extends south from Monterey Bay over one hundred miles and is from five to fifteen miles wide. The most important mineral developments in this county during the last year have been made in the mountains, both on the eastern and western sides of the valley, in the southern end of the county. Starting, therefore, from the county seat, it is necessary to proceed up the Salinas Valley in order to reach the districts demanding our attention. The road from Salinas to King City follows the course of Salinas River, which, rising in San Luis Obispo County, flows through nearly the entire length of Monterey. This river is by no means a navigable stream, the greater part of its course being dry, or almost dry, during the summer months.

The valley is formed of alluvium derived from the degradation of the granitic, serpentine, chloritic, and sandstone formations, of which the mountains on either side are composed. Above this alluvium, and intermingled with its upper layers, is the modern detritus and fluviatile additions. How little denudation has taken place of late years is evidenced by the remains of ancient terraces, both upon the valley surface and the edges of the hills. The lower sixty miles of this valley is a series of low, flat terraces, which extend in a northerly and southerly direction.

The bed of the Salinas River is a white, micaceous sandstone, which forms quicksand, rendering fording dangerous. During the summer season this river, at Soledad, is a broad, sluggish stream. When next encountered, a few miles from King City, the river bed seldom contains any water after the month of June, unless it be in holes formed in the sand during the winter months.

Leaving the Salinas Valley at King City, the road towards Peach Tree lies over the hills of sandstone. From Peach Tree the road towards Slack Cañon lies through a high metamorphosed section of country, if we may

judge from the accumulation of jasper and granitoid rocks brought down by the mountain streams, the beds of which are usually a mineralogical collection, fairly well representing the region from whence they came. As one approaches Slack Cañon Post Office, the physical aspect of the geological formation has a particularly torn and weird appearance, the rocks being principally jaspered slate and more or less metamorphosed conglomerates, until crossing a little creek the contact between the slate and the sandstone is reached. A steep mountain here commands a grand view of the country toward the ocean, and a precipitous descent leads into Indian Valley and to the headwaters of Indian Creek.

Turning eastward from the creek, a steady climb of about two miles brings the traveler into Stone Cañon. In this cañon is situated what is commonly and erroneously known and spoken of as the Slack Cañon Coal Mine.

STONE CAÑON COAL MINE.

This mine is situated in Sec. 14, T. 22 S., R. 13 E., M. D. M. The cañon in which these coal measures are exposed runs nearly east and west, and may be regarded as a dividing line between the sandstones which lie to the west and an extensive district of metamorphosed slate and jasper which lies to the south. They are first observed at the southern base of the mountain which forms the northern wall of Stone Cañon, and rise to a height of about three hundred feet above the coal formation. This mountain is composed of sandstone at the summit, and is somewhat fossiliferous. About fifty feet lower down it is a coarse, crystalline sandstone, the siliceous cementation and quartz granules being distinctly marked. Lower down the sandstone is less crystalline in appearance, and occasionally contains tiny pebbles, which is one of the characteristics of the sandstone overlying the head-wall to the coal below. Lower down and immediately over the head-wall, the tiny pebbles become more numerous, and the sandstone contains fossils. The sandstone forming the head-wall is of a light gray variety and streaked with oxide of iron. This head-wall sandstone appears to be thirty or forty feet in thickness. The coal itself is about twelve feet thick and seems to be a good quality of lignite. It rests upon a tenacious clay, much stained with carbonaceous matter and oxide of iron.

To the south of the foot-wall is a stratum of fine grained sandstone, cropping out in peaks upon the north side of the cañon, and widely extending upon the south side are metamorphic slates passing into both white and red jasper.

This mine was discovered about eighteen years ago, and is bonded by the Pacific Coast Improvement Company, of San Francisco. The works consist of four openings in the above named cañon, two of which are tunnels and two are inclines. The tunnels, an upper and a lower, are the most easterly workings, and have been run in an easterly direction along the strike of the vein. The lower tunnel is about one thousand three hundred feet long and the upper about three hundred feet.

The vein, which is twelve feet wide, pitches towards the north, at an angle of about 80 degrees. The foot-wall is a clay stained with iron and carbonaceous matter, and the hanging-wall is a light-colored sandstone streaked with oxide of iron. The tunnels have been worked a little over a year, and are in coal, about one thousand tons of which have been taken out.

For the first one hundred feet in the lower working, and for a short distance in the upper, the coal has been burned and the adjacent rock fused, filling the vein with clinker. About a quarter of a mile west of the tun-

nels are two inclines, one being one hundred and twenty feet and the other one hundred and sixty feet deep; these follow the vein down, which here pitches at an angle of about 35 degrees, a little to the east of magnetic north. A short distance to the northwest of the tunnels the cañon makes a bend, crossing the coal measures between the tunnels and the incline. Both inclines are now (date July 3, 1888) filled with water, but the Superintendent of the mine states that the coal vein at the bottom is of the same dimensions as that noted in the tunnel. These inclines are about to be pumped out with a Knowles plunger, which has a capacity of twenty thousand gallons per hour.

It is said that these inclines are troubled with sulphurous gas, which is so bad that no one can work in them for longer than an hour at a time; and that a sulphur spring, which formerly existed in the cañon, has disappeared since the inclines have reached their present depth. The coal is hauled by teams from the mines to San Miguel, a distance of about twenty miles.

COAL NEAR PEACH TREE.

A large body of coal has also been discovered a few miles east of Peach Tree, and sixteen miles from the line of the railroad. The deposit is reported to consist of nine distinct veins some eighteen or twenty inches apart, and from eighteen to thirty-six inches wide at the surface. From the indications it is thought that the several veins will converge and form a solid stratum of coal at no very great depth. Practical tests have shown the coal to be of good quality.

CARMEL COAL MINES.

Some years ago a company was organized to develop coal mines at the Chiquito Rancho below Monterey. Considerable work was done and some coal shipped. A rail or tramway was built from the mine to the beach, a distance of five miles, and a chute constructed to load vessels. Owing to dissensions in the company, and the fact that the land was in litigation, the mine was abandoned, and the railway and chute allowed to go to decay. Now that the title of the land has been settled it is presumed that the mine will be taken hold of by experienced parties, as it is believed that immense deposits of excellent coal exist in that vicinity.

PETROLEUM.

The petroleum discoveries in the Little Cholame Valley are now likely to be turned to some practical account. A company has been organized under the name of the Cholame Valley Oil Company. An outfit for sinking and tools are now on the ground. The oil fields are situated from one mile to seven miles north by northwest from the town of Parkfield, and the whole county thereabouts is reported to have been staked off in claims of twenty to eighty acres each.

INFLAMMABLE GAS.

Inflammable gas is said to have been struck near Salinas, at a depth of one hundred feet. No use, as yet, is made of it.

GOLD AND SILVER.

Important discoveries of gold and silver have been made during the last year in the Los Burros Mining District, in the southern end of the Santa Lucia Range, and ledges of auriferous quartz are said to have been found in the Cholame Valley, also near Cholore Peak, in the Gabilan Range.

LOS BURROS MINING DISTRICT.

This district, which covers a wide area in the southern portion of the Santa Lucia Range, was organized in 1876. Prior to 1887 no mineral veins of importance had been discovered, the prospectors principally confining their attention to quicksilver and placer workings. Although several quicksilver claims were discovered, but little was done toward their development. Placer mining was carried on intermittingly for several years. At one time over one hundred Chinese were engaged in gold washing in the vicinity of Jolon, it being supposed that the land in that neighborhood was Government territory. It proved, however, to belong to the Milpitas Grant, and the owners compelled the Chinamen to discontinue their work. Gold washing was afterwards carried on further west, in the ravines and gulches of the Santa Lucia Range. The gold was principally coarse gold nuggets, some of the value of $5 being occasionally found.

From the desultory character of the workings, it is naturally difficult to form any estimate of the amount of gold that has been obtained in this district; but in 1877 and 1878 Messrs. Dutton & Tidball, who owned a store at Jolon, took in $2,500 in gold dust from the Chinamen.

In 1887 W. D. Cruikshank was prospecting in Alder Creek, and discovered a "blind lead" from two to four inches wide, containing free gold. He commenced sinking upon it, and the ledge widened out as he went down. He then crushed about twenty pounds in a hand mortar, and washed out $18 worth of gold. He continued sinking, and put up a horse arrastra. This he used for about four months, during which time he realized sufficient to erect a three-stamp mill and a two-horse-power engine. He ran this mill from November, 1887, to the first of June, 1888, when a failure of the water supply, caused by draining the upper workings of the mine, compelled a removal of the mill, and a consequent temporary suspension of milling operations. Further developments of Mr. Cruikshank's mine, which is called the Last Chance, have brought to light five distinct leads, each showing well defined quartz veins, three of which have been found of sufficient importance to work.

THE LAST CHANCE MINE,

Which has proved the initial of the renewed vitality that has been infused into this section, is situated on the western slope of the Santa Lucia Mountains, at the height of about two thousand eight hundred feet above sea level. It is distant about twenty miles southwest from Jolon, nine miles north of the San Luis Obispo County line, and three miles from the ocean.

The Santa Lucia Mountains extend from Carmelo Bay in an unbroken line southeast, bordering on the coast as far as San Luis Obispo, then trending to the east they verge into the main Coast Range. They are a rugged mass with an average breadth of eighteen miles, and reach an elevation of some five thousand feet at the highest point. The road from Jolon towards the Los Burros Mining District extends through grants of Milpitas and Pyojo, which are devoted to stock raising. Across the San Antonio Creek

to the Nacimiento River the wagon road ends; from here goods are packed to the mines on animals. This station is probably half way, in point of distance, from Jolon to the mining town of Alder Creek. The mule trail here ascends the mountains, winding amongst ruined crags of sandstone and conglomerate, which form the first tier of mountains in this portion of the Santa Lucia Range.

Crossing a ridge at the height of about one thousand seven hundred feet above sea level, the trail bends more to the west in order to avoid a deep ravine, and at the distance of about two miles from the Nacimiento River a good spring of water is reached. A trail here leads off to the mines belonging to Belleau, Fancho, and Arbold. Both light and dark-colored serpentine rocks now make their appearance, and a fine growth of pine, oak, manzanita, and madrona. Masses of quartz which have fallen from a higher elevation incumber the trail at several points. These are of a light color, though often stained with iron, and are a characteristic feature of this portion of the Santa Lucia Range.

The trail here winds to the west of south along a spur of one of the central ridges of the main range. The formation at this point appears to be metamorphosed slate and sandstone.

About six miles from the Nacimiento River is a good spring of water called Round Spring. It is now taken up as a mill site. A mile further to the west there is a third spring. This is at a height of about two thousand seven hundred feet. Just below the spring ledges of sandstone, interstratified with shale, crop out, dipping to the east at an angle of 40 degrees, while masses of quartz which have fallen from the bluff above strew the mountain side, and in places conglomerate crops out, apparently conformable with the sandstone formation. From here the trail ascends to the divide, which is reached at the approximate height of three thousand five hundred feet. The ridge at this point is composed of altered sandstone, varying somewhat in character and degree of metamorphism, and occasionally traversed with seams and interstratifications of quartz.

The developments of the Last Chance Mine consist of a tunnel, a shaft, and several open cuts, from which ore has been taken, and a second tunnel now being made for drainage purposes and to tap the vein at a lower depth.

Although five veins have been discovered on this claim, only three have been found of sufficient importance to work. The greater part of the ore mined has been taken from the middle vein, which has a strike northeast by southwest.

An open cut here exposes the country rock for several feet, the vein itself being covered with debris that had recently fallen in. Country rock at this point is slate, being friable where long exposed, but blue and hard when first uncovered. The vein here is from one to two and one half feet at the top, but it widens with depth. Good pay ore was milled from this vein from December 15, 1887, to the middle of June, 1888. About eighteen feet north of this middle vein a smaller vein was discovered, running at an angle to the middle vein for a short distance, and joining it near the center of the claim. This vein is from two inches to eight or ten inches in width, averaging perhaps six inches. The gangue in both veins is quartz. It was in this little vein that some of the richest ore was found, specimen pieces showing a large percentage of free gold. Where the two veins came together there was no perceptible increase in their size or richness.

About thirty feet below, this vein has been worked by what is known as the middle tunnel, which extends about two hundred feet along the course of the vein. This tunnel is connected with the surface by a shaft about twenty-seven feet in depth, and reaching about five feet below the floor of

the tunnel. The bottom of the shaft contains four or five feet of water. The vein here is about two feet wide, and stringers at various points run off into the slate walls.

The pitch of the vein is to the west, at an angle of 65 degrees. At the southwest end of this tunnel the vein approaches to within ten feet of the surface, owing to the slope of the hill, and splits into stringers, which run through the slate in a southwesterly direction. The tuunel at no point reaches a depth from the surface of more than twenty-five feet, and has a slightly upward inclination.

A short distance down the hill is the lower shaft. This is about thirty-five feet deep, and was the discovery shaft. The vein at the surface was only one or two inches wide, but showing free gold. This shaft is sunk entirely in slate. At the bottom, the vein, which is about forty inches wide, and somewhat intercalated with slate, pitches to the north at an angle of about 50 degrees. West of the discovery shaft a prospect trench shows the continuation of the ledge to the southwest. The vein appears bent and somewhat irregular in its course; the vein trend is to the southwest. The breadth of the vein is from five to six inches near the surface. The lower tunnel is located about one hundred and fifty feet below the upper workings, has a length of two hundred and fifty feet, and is being extended. Its direction is west of north into the mountain. The formation penetrated is slate, traversed occasionally by little stringers of quartz. This slate in some places contains much iron pyrites.

THE CRUICKSHANK MILL,

Has three stamps, which crush four tons of ore in twenty-four hours, through a forty-mesh screen. Fifteen men are employed in and about the mine and mill.

THE MARS MINE,

Is the southwest extension of the Last Chance Mine. A tunnel having a present length of about seventy-five feet is being driven in a northerly direction for the purpose of striking the ledges on the Last Chance claim. Much placer gold has been discovered in the ravine below, and upon the mountain's side. The working commences in a hard slate, the formation running east of north by west of south, and passes after a few feet into softer rock. A vein fourteen or fifteen inches wide was passed through within twenty feet of the mouth of the tunnel, which "prospected" in gold. From that point on the formation is slate, intersected by stringers of quartz.

THE MANCHESTER MINE

Adjoins the Mars on the east, and is being opened by a tunnel which now has a length of fifty feet, with a course west of north, and by a shaft which has reached a depth of thirty-five feet. The tunnel is crosscut about thirty feet from the mouth for a few feet along the vein. The vein, about two feet wide, is quartz, mixed with slaty matter, and dips to the southeast at an angle of about 65 degrees. Much of this ore prospects in the pan.

THE GRAND PACIFIC MINE

Has a shaft fifty feet deep and numerous crosscuts and holes. The vein has a quartzose gangue and is about fifteen inches wide at the top of the shaft, from where it dips to the southwest at an angle of about 70 degrees.

Some twenty-five feet below the surface the vein contracts to about four inches in width and turns in an opposite direction. A tunnel four hundred feet in length will be run into the hill in order to drain the mine and strike the vein at a lower depth.

THE OPHIR MINE

Lies to the west of the Grand Pacific, and is being worked through a tunnel and an incline shaft, each being thirty feet in length. Several stringers of quartz, mixed with slate, have been encountered in the workings.

THE OLD MAN OF THE MOUNTAINS CLAIM

Lies west of the Ophir. Placer gold has long been worked on the northern portion of the center line of this claim, and it is believed that with sluicing the property would pay from $3 to $5 per man per day. There have been three tunnels run in on this property, but other than a few stringers of quartz there were not any findings of importance.

MELVILLE MINE.

This mine was located June 8, 1887. A tunnel is here being run to strike a quartz vein at about three hundred feet distant.

A short distance to the south of the Grand Pacific claim ledges of quartz rock protrude through the slate, along the crest of the mountains. These ledges do not appear to have any relation to each other, their strike generally being dissimilar.

THE BLACK CRYSTAL CLAIM

Is reached by ascending a ridge of light-colored serpentine. Here are croppings of manganese, through which runs a small vein of quartz. Extensive prospecting was done here by Moor Brothers & Co., who found placer gold in the gulch below, and prospected for the ledge, but without success. From this point the serpentine extends, for about four hundred yards, in a southwesterly direction.

The Black Crystal Mine is located on the edge of the above formation, and the croppings show carbonate of copper. Southwest of the Black Crystal claim is a ridge of amygdaloid serpentine, containing crystals of calcite. These crystals are weathered out upon the exposed surfaces, leaving a versicular rock, much resembling a lava. This ridge extends to the sea.

Further south, at a lower elevation, the slate is again encountered. In the latter two tunnels have been run to strike a small vein of quartz, which had been discovered in the hill above, and located as the Eclipse. The lower tunnel is one hundred and thirty feet long, but it has not yet reached the ledge. The upper tunnel is fifty feet long, and in it a small vein of quartz was cut through, but it pinched, within a short distance, to one inch. In prospecting further, by continuing the tunnel, a small seam of auriferous clay was struck, which showed rich in the pan.

Ascending again to the serpentine region, Volcano Point is reached. This is one of the stations of the Geodetic Survey, and is about two thousand five hundred feet above the level of the sea. From this point bluffs, carrying masses of serpentine, lead down to the seashore.

THE STONE WALL MINE

Is about one thousand three hundred feet from the Melville Mine, lower down, toward the ocean, and has a two-foot vein of quartz, mixed with slaty matter, dipping to the northwest at an angle of 45 degrees. The ore shows galena distributed sparingly through it. The mine is situated on a precipitous bluff, overlooking the sea, which is distant probably half a mile in an air line. A steep slope, covered with brush and broken serpentine, leads down to the seabeach.

THE BREWERY MINE

Is located about two miles northwest of the little settlement of Alder Creek, and is worked through two tunnels; but perhaps the ledge is best exposed in the bed of a small stream, above the lower tunnel, which has a trend of northeast to southwest, and is about three feet wide.

A little further up the creek is a promising prospect, into which two tunnels are being run. Here specimens containing free gold are frequently found. There are quite a number of encouraging prospects in this vicinity.

THE KING MINE

Was located in May, 1887. Much placer gold was discovered in the gulch below to the south of this claim, some pieces reaching a value of $5. A tunnel ninety feet in length has been run in a northerly direction into the hill on this claim, for the purpose of striking the vein from which the placer gold came. The working is in slate, in places inclined to be sandy, and traversed occasionally by stringers of quartz, one of which prospects a little free gold. A contract has been let to continue the tunnel for one hundred and fifty feet.

THE AJAX MINE,

Located in June, 1887, has a tunnel run into the hill at a distance of two hundred and nineteen feet in an easterly direction, and a crosscut of twenty-one feet. One hundred and forty-six feet from the mouth of the tunnel are several irregular veins of quartzose rock mixed with clay and slate, the whole constituting a vein from three to four feet thick. The strike is northeast by southwest. The dip is too irregular to determine, as a cave had partially obscured the vein at the point where it was most clearly defined.

THE SCORPION MINE

Is situated on the eastern side of the divide, and, so far as developed, the prospects are very encouraging.

Further to the west in the Santa Lucia Range the formation is granitic, and veins carrying both gold and silver are said to occur therein. That section, it is stated, is now being prospected, and some claims are being developed. Time at command would not allow a visit to that district during this season.

WOOD AND WATER.

There is an abundance of wood for mine timber and other purposes on the western slope of the mountain range. It is doubtful whether enough water could be found, in the immediate vicinity of the mines already opened, for milling purposes on anything like an extensive scale. There

are many suitable mill sites between the settlement of Alder Creek and the ocean.

All the ore yet worked in the Los Burros Mines is free milling, containing gold and silver, the principal value being in the gold. Except in the case of Last Chance Mine, the actual value of the ore is a matter of demonstration. The miners in this district are confining their determinations of values pretty much to washing tests in horn and pan.

TABLE

Showing work done on claims in Los Burros Mining District, as far as can be learned up to August 1, 1888.

Name of Mine.	Approximate Number of Feet.	Name of Mine.	Approximate Number of Feet.
Ajax	240	Tidball	30
King	90	Mars	75
Emerald	100	Murray	150
Manchester	85	Eclipse	180
Last Chance	500	Brewery	74
Grand Prize	50	San Juan	50
Grand Pacific	50	Ivanhoe	50
Sunrise	100	Eureka	15
Santa Clara	20	Old Man of the Mountain	185
Prospect	50	Cañon	25
Volcano	20	Melville	20
Queen	30	Ophir	60
San Vincent	15	Scorpion	30
Hitchcock	50	Turtle Dove	35

SUMMARY.

There are three characteristics that cannot escape the attention of an observer in the Los Burros Mining District: Firstly, the placer gold is mostly coarse gold, rough and angular, often adhering to fragments of quartz. Therefore the gold cannot have traveled very far. It must have come from the disintegration of rocks in the immediate vicinity.

Secondly, the numerous small irregular veins which traverse the various formations, from the erosion of which much of the placer gold has probably been derived. The gold in the bottom of the ravine is a concentration from the whole mountain side, not necessarily coming from one original source.

Thirdly, the strike of the principal veins corresponds in most instances to the strike of the country rock, showing that the veins occupy fissures that must have coincided with the original lines of stratification in the upturned sandstones and slates.

THE ROCKLAND LIME AND LUMBER COMPANY.

These works are situated twenty-eight miles below Point Sur, or sixty miles from Monterey, and about half a mile from the ocean, in Sec. 8, T. 12 S., R. 3 E., M. D. M. There is an inexhaustible supply of lime rock and a large forest of redwood, pine, laurel, and oak, from which to obtain fuel and material for the manufacture of barrels. A road three thousand seven hundred feet long, with a slight down grade, and cut almost in solid rock, leads from the works to the shipping point. The latter is located on a bold point extending into the ocean, and about one hundred and fifteen feet high. From this point a steel cable extends out into the ocean one

thousand feet to a four thousand-pound anchor in ten fathoms of water. The vessel is moved directly under this cable, about four hundred feet from the cliff, and a car or basket runs back and forth over the cable, by which means the vessel is loaded and unloaded. The works of this company consist of four patent perpetual kilns, with a capacity of one hundred and ten barrels each per day. These kilns consume seven cords of wood to every one hundred barrels of lime burned.

MINERAL SPRINGS.

Monterey County claims to have within her boundaries some of the best medicinal springs to be found on the coast.

THE TASSAJARA SPRINGS.

The Tassajara Springs are situated in a deep wooded cañon in the Santa Lucia Range, about fifty miles south of Salinas City. The beneficial qualities of the water have long been known to the Indians and all old settlers, and many make yearly trips to these springs, despite the fact that they are almost inaccessible. They are said to be especially beneficial for kidney diseases and stomach troubles. There are in all twenty-nine mineral springs, varying in temperature from cold to boiling heat. A finely graded road, fifteen miles in length, has been built over a spur of the Santa Lucia Mountains, and will soon be thrown open to public travel.

LITTLE SUR HOT SPRINGS.

Little Sur (Little River) Hot Springs are situated about twenty-five miles down the coast from Monterey, in a beautiful cañon on the north fork of the Little Sur. The principal springs are situated about fifty feet above the river channel, and pour into a natural bathtub worn out of the granite rock, large enough for four persons to bathe in comfortably at the same time; although for a distance of about a quarter of a mile the water oozes from the rocks in several places, and is plainly seen boiling up from the bottom of the stream several feet under cold water. The temperature of the springs in the bathtub ranges from 60 degrees to 120 degrees. These springs are partly owned by Dr. S. M. Archer and Wm. Kelcher.

SLATE'S SPRINGS

Are situated in a beautifully sheltered cañon close to the beach, about twenty miles below the Little Sur Hot Springs. They were located in 1870. The waters of the springs are said to be similar to those of the Tassajara in their quality. But little has been done toward making the place a health resort, on account of its distance from the railroad and the difficulty in getting there.

NAPA COUNTY.

The name of this county is of Indian origin, the word having first been applied to the river that flows through nearly its whole length from north to south. Napa is bounded on the north by Lake, on the east by Yolo and Solano, on the south by Solano and Contra Costa, and on the west by Sonoma County.

This county consists almost wholly of Napa Valley, a broad depression, reaching its entire length, and of the two ridges of the Coast Range that flank it on either hand; the Mayacamus ridge on the west separating this county from Sonoma. At the head of the valley stands Mount St. Helena, having an altitude of four thousand three hundred and forty-three feet, forming the culminating peak in this part of the Coast Range. Knights and Berryessa Valleys, situated in the northwestern part of the county, are noted for their rich soil, and the bountiful, never-failing crops of grain they produce. Putah Creek, the only large stream in the county besides Napa River, flows southeast across its northeastern corner. The mountains to the north are well timbered; further south the tree growth is more sparse and scrubby, with only large oaks scattered throughout the valleys.

MINES AND MINERALS.

While Napa is distinguished as a fruit, grain, and vine-growing county, it possesses also a variety of mineral products, of which gold, silver, mercury, iron, chromium, and manganese are the principal.

THE QUICKSILVER MINES.

The cinnabar deposits occur in the northern part of the county, where several companies are engaged in this branch of mining.

LAKE COMPANY.

The interests of this company having been consolidated with those of the Manhattan, there are now under one control fourteen claims, fifteen hundred by six hundred feet, and the Manhattan, located in 1862, which is three thousand by six hundred feet. These properties lie about two miles west of Knoxville, and eighteen miles east of the town of Lower Lake. The cinnabar is associated in the vein with siliceous shale, chalcedony, and jasper, carried in a porphyritic dike, having walls of sandstone and serpentine. The vein here has a general northeast and southwest course, dipping from 45 to 60 degrees to the northeast. It varies in width, the ore being found through it in shoots and pockets. Secondary dikes have cut through the formation, the deposition of cinnabar in the vein having occurred, evidently, subsequent to the intrusion of the secondary dikes, as they are charged with that mineral. The principal work has been done in cuts and tunnels, some of the latter being three hundred feet in length, with a depth, under the surface, of two hundred feet. A shaft is now being sunk, which, it is intended, shall go to a depth of two hundred and fourteen feet. About two hundred pounds of No. 2 Giant and some black powder are used per month. When necessary, pine and spruce timber, brought from Lower Lake, is used. From the tunnels and cuts the ore is transported to the reduction works in carts. The fine ore is treated in a Knox & Osborn furnace having twenty tons capacity per day; the coarse ore in a twenty-ton reverberatory furnace, so arranged that the flames pass over the hearth and return under it. Each furnace is connected with a condenser constructed of brick and iron, each of them having thirty-eight chambers nine feet long, three feet wide, and eight feet high.

NAPA CONSOLIDATED COMPANY.

The mines of this company are located at Oat Hill, nine miles southeast of Middletown, where they own six claims, one thousand five hundred by six hundred feet each. The mine is worked through various tunnels and a shaft nine hundred feet deep, the latter fitted with a six by twelve double, reversible, spur-geared hoist. The vein, having a course northwest and southeast, dips to the northeast at an angle of 42 degrees. It cuts through volcanic scoria, with occasional clay slate on the hanging-wall, the cinnabar being found in it associated with quartzite and sandstone. About three thousand gallons of water are hoisted here daily. A National air compressor is running for the purpose of ventilating the mine, no power drills are used. Safety Nitro powder is employed for blasting. Pine timber, cut on the company's property, in the vicinity, is used for timbering; as the ground is swelling a great quantity of timber is required. Some eight miles of wagon road have been constructed by the company. The main shaft is connected with the reduction works by a tramway, mules being employed for hauling the cars. The fine ore is sublimated in a twenty-ton Hutner & Scott shelf furnace, and the coarse ore in a ten-ton furnace of the same make, the ore for the former being run through a Wheeler crusher before being charged into the furnace. Brick and iron condensers of twenty-one chambers are connected with each furnace. About eight cords of wood, for all purposes, are consumed daily. The company employs one hundred men—seventy-five in the mine, ten in the reduction works, and fifteen on the outside. Of the other quicksilver mines in this county none are producing at present.

SILVER MINING.

The silver bearing veins in this county are mostly confined to the lower slopes of Mount St. Helena, where a great many claims of this kind were taken up and much work done upon them from fifteen to twenty years ago. As the developments made proved disappointing, operations gradually ceased, the most of these claims having afterwards been virtually abandoned. Although work there has during the past year or two been practically resumed, the only mine that is at present producing bullion is

THE PALISADE,

Owned by Messrs. Grigsby & Johnson. This property, which comprises four claims, each one thousand five hundred by six hundred feet, is located on one of the southerly spurs of Mount St. Helena, near the foot of the grade leading from the town of Calistoga into Lake County. A well built wagon road connects the mine with Calistoga, lying about two and a half miles to the south. Two veins have been developed here, one running nearly north and south, the other lying east of this vein, having a trend more to the west. As yet it has not been shown that these veins intersect; but a prospecting shaft sunk on the more easterly of the two, carried below the depth of the lowest workings in the westerly vein, served to drain both; hence, it may be inferred that these veins intersect at some point to the north. Although the westerly vein is much stronger than the easterly, the average grade of ore extracted from the latter was higher than that coming from the former. These veins fill fissures in altered felsite. The westerly one, which is most developed, dips at the south end of the works to the west, at an angle of 57 degrees. Going north it straightens up until it reaches the perpendicular.

A tunnel five feet in width and nine hundred feet in length has been run in on the westerly vein. It skirted the hanging-wall, and in no place was it found necessary to cut into the foot-wall to gain room for the tunnel. Near the present northern breast of the tunnel a crosscut has been driven at an angle of about 70 degrees with its course. This crosscut, some six hundred feet long, comes out on the westerly side of the hill at the mill, and about twenty-five feet above the level of the ore dump. Near the entrance of the main tunnel a winze has been sunk on the vein to the depth of one hundred and sixty feet, from the bottom of which drifts have been run to the north and to the south. A shaft one hundred and seventy feet deep, started on the easterly vein, at a point a little east from the mouth of the main tunnel, passes through the vein into the foot-wall; a crosscut at the bottom of this shaft intersects the easterly vein and connects the shaft with the lower works on the westerly vein. From this crosscut the easterly vein has been prospected to the north. In the upper, or tunnel level, nine hundred feet of drifting has been done on the vein; in the lower level, one thousand two hundred feet.

There is in sight in the mine some two thousand tons of ore; this calculation being based on the amount of ore extracted from the present works. The exact value of the ore taken from the mine is not officially known, though it may be safely placed at thirty ounces per ton. The two hundred tons of selected ore shipped from the mine gave a return of over one hundred ounces to the ton. No stoping has been done here, there being enough ore on the dump to supply the mill for some time to come. The matrix of the ore in the westerly vein is a coarse-grained friable quartz, carrying sulphide, arsenides, and antimonides of silver, with some iron pyrites. The ore in the easterly vein is similar, except that the quartz is much more compact.

From the mine, by means of a tramway laid along the crosscut from the main tunnel, the ore will be delivered directly into the mill dump. This mill (completed in June last) has been remodeled from a wet to a dry crusher. It carries ten seven hundred and fifty-pound stamps; drop, eight inches, ninety times per minnte. About seventeen tons of ore per day are crushed here, through a twenty-four-mesh brass wire screen. The ore, mixed with from 7 to 10 per cent of salt, is dried by the exhaust gases from the fifty-four-inch White furnace, in which the chloridation is effected. The arrangement for drying the ore is novel, consisting of four inclined chambers some ten feet long by four feet wide, set at an angle of 34 degrees. These chambers, which have a cast-iron bottom and a sheet-iron top, are set side by side, with openings in the partition walls for the free flow of the heated gases. The products of combustion from the roaster are made to pass under the bottom of these drying chambers, and then return through them. A thorough drying is effected, and it is claimed that the escaping moisture from the drying ore acts as a precipitant on the dust, which is mechanically carried off from the roasting furnace. These driers do not impair the draft of the roasting furnace; on the contrary, they seem to aid it. The ore mixed with the salt is banked against an opening at the upper end, about six inches high and the width of the chamber. Through a similar opening at the lower end the charge is drawn off as needed. The angle of the bottom is sufficient to cause the ore to slide down as that below is withdrawn, thus making the drier, to a certain extent, automatic. From the battery, which is fed by a shaking apron designed by Mr. Grigsby, the ore is conveyed to an elevator by means of an endless screw. This elevator raises the ore and charges it into the White furnace, where it is chloridized to 90 per cent. The chloridizing,

roasting, and drying consume $\frac{11}{100}$ cord of wood per ton of ore treated. No chemicals are added to the pan charge; from 85 to 90 per cent of the value is saved.

Length of ore shoot	900 feet.
Depth of ore shaft vertically	170 feet.
Vertical depth reached in mine	423 feet.
Quantity of water raised in twenty-four hours	1,000 gallons.
Character of walls	Altered felsite.
Kind of powder used	Vigorit.
Number of feet timbered	Very little.
Kind of timber used	Pine.
Length of road built	2 miles.
Character of ore	Quartzose.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamps	8 inches.
Drops	90 per minute.
Duty of stamp	1.7 tons in twenty-four hours.
Kind of shoes and dies	Chilled cast-iron.
Size and character of screens	34-mesh brass wire.
Kind of feeder	Shaking apron.
Kind of pans	Combination.
Number of pans	4
Percentage of value saved in pans	85 to 90
Kind of roasting furnace	White.
Number of roasting furnaces	1
Percentage of salt used in roasting	7 to 10
Wood consumed in roasting	$\frac{11}{100}$ cord per ton of ore.
Percentage of silver chloridized	90
Number of men in mill	8
Number of men in mine	4
Total number employed	12
Average wages paid	$2 per day.
Wood used	5 cords per day.
Cost of wood	$3 50 per cord.

OTHER METALS AND MINERALS.

Gold-bearing quartz veins crop out at many places on Mount St. Helena. Although a good deal of prospecting has been done on these veins, nothing of large value has ever been developed.

In the same neighborhood occur deposits of iron ore. From one of these, known as the Sterling Mine, a small quantity of ore has been extracted, this being the extent to which these ferruginous deposits have been worked. Associated with this iron ore is a small percentage of manganese.

In Pope Valley, Childs Valley, and near St. Helena, deposits of chromic iron ores exist, but little or nothing has ever been done with them.

In the valley of this county beds of clay, well adapted to the manufacture of brick, abound. Near Napa City a clay is dug and shipped to the pottery of Clark & Son, in Alameda, where, after being mixed with a clay from Amador County, it is used for the manufacture of sewer tile, about one hundred and fifty tons of this material per month being consumed for such purpose. This clay is also used on the spot for making pressed brick and drain tile.

Near the same locality occurs a bed of fire clay, which, being hard and dressing well, is used somewhat as a lining for fireplaces.

Building stones of different kinds are plentiful in this county. Two miles southeast of Calistoga a quarry of fine-grained stone has been opened. It dresses well, and varies in color from light yellow to dark gray. When first quarried this stone is very soft, but, upon exposure to the atmosphere, it gradually hardens. Trachytic tufa is being quarried on the Berryessa road, some four miles northeast of Napa, and is at present being used in the construction of vaults and curbings in the cemetery of that city.

In Gordon Valley, eleven miles east of Napa City, a quarry is being worked from which is extracted a very superior quality of sandstone. The stone is of a dark pearl gray, very even in texture and color. It is easily worked, when freshly quarried, but hardens on exposure.

Near the Insane Asylum, at Napa City, a good rubble stone is quarried, but being iron-stained it is not in much demand.

MINERAL SPRINGS.

NAPA SODA SPRINGS.

These springs, which have some fame as a resort, and the waters of which are bottled for export, lie in the hills six miles northeast of Napa. There are twenty-seven springs of carbonated saline water, the temperature of which is 68 degrees Fahrenheit. An analysis made by Dr. Lanzweert gave the following in grains to the gallon:

Bicarbonate of soda	13.12
Carbonate of magnesia	26.12
Carbonate of lime	10.83
Chloride of sodium	5.20
Subcarbonate of iron	7.84
Sulphate of soda	1.84
Silica	0.62
Alumina	0.6

ÆTNA SPRINGS.

These springs, several in number, are located sixteen miles northeast of St. Helena, near the head of Pope Valley. They are much resorted to, and the waters are bottled for export. The temperature of the water ranges from 98 degrees to 106 degrees Fahrenheit. An analysis by J. A. Bauer gives in grains to a gallon the following:

Sodium carbonate	75
Magnesium carbonate	14
Calcium carbonate	10
Sodium sulphate	8
Sodium chloride	29
Silica	Trace.
Total	136

One gallon of these waters yielded fifty-eight cubic inches of carbonic acid gas.

CALISTOGA.

At Calistoga there are some twenty hot saline springs. The analysis of the water by J. T. Rudolph gives in grains to the gallon:

Sodium carbonate	3.41
Potassium sulphate	1.61
Magnesium sulphate	0.47
Sodium chloride	22.25
Calcium chloride	3.26
Alumina	Trace.
Silica	6.50
Total	37.50

These waters give of sulphuretted hydrogen three, and two hundred and seventy-one thousandths cubic inches to the gallon.

WHITE SULPHUR SPRINGS.

Two and one half miles south of St. Helena there are nine springs whose waters are sulphuretted, and whose temperature is from 69 degrees to 89.6 degrees Fahrenheit. These springs are used as a resort.

NEVADA COUNTY.

This county derives its name from the Sierra Nevada Mountains, which occupy the whole of its upper eastern half. It is bounded by Yuba and Sierra on the north, by the State of Nevada on the east, by Placer on the south, and by Yuba County on the west. Nevada and Placer furnish each a good example of the long, narrow, strangely shaped counties peculiar to the western slope of the Sierra, mentioned in our prefatory remarks.

Nevada is one of the imperial mining counties of California, contesting with Amador the honor of being the largest bullion producing county in the State. The annual output of gold, amounting now to nearly $3,000,000 for each county, would have been much larger but for the suppression of hydraulic mining. The bullion product of Nevada has suffered the largest curtailment from this cause. Every form of gold mining elsewhere pursued is represented in this county, gravel washing by the hydraulic process alone excepted; this, after reaching here its greatest expansion, having been prohibited by the Courts. In Nevada County, California, gold quartz mining had its origin; the business having begun at Grass Valley as early as 1850, in which year the first quartz mill in the State was erected. In Nevada, also, auriferous gravel washing by the hydraulic method was invented and first practiced, the process having afterwards in this county seen its most extensive application. Here are found the longest and most expensive water ditches and the most capacious reservoirs, constructed in this or, perhaps, in any other country. The record made by some of the quartz mines of this county is very remarkable, both as regards large, long continued, and steady production. The ores here are for the most part of good grade and free milling, carrying usually not over 2 per cent of sulphurets. The concentrates yield on an average about $100 per ton. The ore is chiefly gold-bearing quartz, while the veins are not apt to be large, ranging generally from two to three feet in thickness.

The surface of this county is uneven throughout, the great snowy range covering its eastern, and the foothills its western part. With the exception of the Truckee River, which flows across its southeastern corner, and the South Fork of the Yuba, flowing centrally through it, there are no large streams wholly in Nevada, the Middle Yuba separating this from Sierra County on the north, and Bear River separating it from Placer County on the south. There are several small lakes in the upper part of the county. Of these, Donner, some two miles long, and situated east of the main summit of the Sierra, is the principal. Except a narrow strip along its western border, the county is well timbered. The principal towns and mining localities are Grass Valley, Nevada City (the county seat), North San Juan, Sweetland, Birchville, French Corral, Rough and Ready, Spenceville, North Columbia Hill, North Bloomfield, Moores Flat, Washington, Eureka, Little York, and You Bet. Truckee, a large town in the eastern part of the county, being the center of important lumber operations.

QUARTZ MINES AND MILLS OF THE COUNTY—NEVADA CITY DISTRICT.

The quartz mining in the vicinity of Nevada City has, for the past year or more, suffered some depression, a condition of things due to the impoverishment of the ore in certain of the mines, and a partial exhaustion of ore bodies in others. Recently operations in some of these mines have been resumed, there being also an increased amount of work done on others not yet so much developed. That the improvement noticeable in the situation here will be permanent, there are good reasons to believe.

PROVIDENCE MINE.

This property is situated on Deer Creek, one and one half miles below the City of Nevada, at an altitude of two thousand five hundred feet. After having given the mine for some time over to tributers, the company on the sixteenth day of June, last, resumed the employment of the men at daily wages, starting at the same time twenty stamps of the mill. One week later the mill was shut down and the mine again let to tributers. During the past year the shaft has been sunk one hundred and fifty feet, and five hundred feet of drifting was done on the one thousand two hundred and fifty-foot level. While the vein presented a fair appearance the rock did not pay enough to justify a continuance of the work.

NEVADA CITY MINE.

This mine is situated on Deer Creek, two miles below the City of Nevada. The vein here is a narrow one, its average thickness in the upper levels not exceeding seven inches; at greater depths, however, it shows at some points a thickness of two feet.

Course of vein	North and south.
Dip	49 degrees easterly.
Length of ore shoot	300 feet.
Length of tunnel	750 feet.
Depth of inclined shaft	260 feet.
Water coming in	Very little.
Kind of pump	Cornish.
Powder used	Giant, No. 2.
Amount of powder used	3 cases per month.
Cost of mining of ore in pay shoot	$8 per ton.
Cost of tunnel	$5 per foot.
Number of feet run per day	2
Cost of sinking shaft	$11 per foot.
Formation passed through	Granite.
Number of stamps	10
Weight of stamps	850 pounds.
Drop of stamp	6 inches.
Drops	85 per minute.
Duty per stamp	2 tons in twenty-four hours.
Metal used for shoes and dies	Iron.
Cost of shoes and dies	5 cents per pound.
Wear of shoes and dies	1 set to 300 tons of ore.
Battery screens	No. 6, round punched.
Discharge surface of screen	3 feet 4 inches by 16 inches.
Size of apron (silvered)	4 feet by 9 feet.
Inclination of apron	1.75 inches per foot.
Frue concentrators	2
Percentage of sulphurets	About 7
Value per ton of sulphurets	From $80 to $225 in gold.
Number of men in mine	4
Number of men in mill	2
Total number employed	6
Wages paid in mine	$3 per day.
Wages paid in mill	$3 50 per day.
Power used	34-foot overshot water wheel with 25 miner's inches of water (6-inch pressure).

The vein was on an average seven inches wide in the upper levels, but a two-foot vein has been developed recently, and has continued for a distance of ten feet.

SPANISH GOLD MINE.

The property owned by the Spanish Gold Mining Company, incorporated ten years ago, is situated one and one half miles west of the City of Nevada. The vein, supposed to be the same as the Providence, strikes north and south, dips easterly at an angle of 45 degrees, and has an average thickness of four feet. The length of the pay shoot is not known. A tunnel, two hundred feet long, cuts the vein at a depth of one hundred feet, at which point an inclined shaft follows it downward fifty-six feet; giving a total vertical depth of about one hundred and twenty feet. The hanging-wall is granite, the foot-wall slate. There is so little water that pumping is not required. The ore, which consists of quartz, carries free gold, with a large percentage of pyrites, and some galena and zinc blende. Length of tunnel, two hundred feet; depth of inclined shaft, fifty-six feet; total vertical depth reached, one hundred and twenty feet.

UNION MINE.

This mine is located about two and one half miles southeasterly from Nevada City, at an altitude of three thousand feet. Active work was begun here last September. The ore since extracted has yielded $18 per ton; the gold being worth $12 per ounce. The sulphurets are worth about $75 per ton, half in gold and half in silver. The mine is worked by the owners in person, only one man being hired. Ventilation is effected by means of a water blast; a very small stream of water, with a fall of one hundred feet, sufficing for the purpose. The water here is not under pressure, as in some cases of water-blast ventilation, but is simply "turned loose" in the center or axis of a square vertical wooden pipe, the lower end of which is submerged in water in a tight wooden box, with an air pipe at the top and an outlet for water at a lower point. The waste water flows out of the mine through an old tunnel. The contrivance is a rude form of the Catalan blower of mining text-books, and answers its purpose very well. The strike of the vein in the mine is north and south; the dip easterly, at an angle of 40 to 45 degrees; the average thickness, ten inches. The claim is one thousand five hundred feet on the lode line, by six hundred feet wide. The length of the pay shoot has not yet been determined. The walls are granitoid. The ore is extracted through a vertical shaft, a drift, and a second shaft, from a total depth of one hundred and eighty-five feet, the little water coming in being raised by a hand pump to the old tunnel level. No timbering is necessary. The ore is quartz, carrying free gold, pyrites, and galena. It is treated by wet crushing and concentration, at the mill of the Nevada City Company, and yields, besides the free gold, some 4 per cent of sulphurets. Developments here, in addition to those mentioned, consist of three hundred and fifty feet of drifts.

Altitude	3,000 feet.
Vertical depth	185 feet.
Length of drifts	350 feet.
Walls	Granitoid.
Value of ore	$18 per ton.
Percentage of sulphurets	4
Value of sulphurets	$75 per ton.
Width of vein	10 inches
Number of men working	4

CHAMPION MINE.

This mine is located one and one half miles west from Nevada City at an altitude of two thousand three hundred feet. The developments here consist of an inclined shaft three hundred feet long, giving a vertical depth of about one hundred and eighty feet, three hundred and fifty feet of drifts, and a little stoping. The mine keeps the mill supplied with ore, which yields from $5 to $9 per ton in free gold and 4 per cent of sulphurets. The latter contains from $70 to $75 in gold per ton. The sulphurets are sold. The claim covers a length of three thousand feet by a breadth of six hundred feet; timbers used are spruce and pine. The ore containes pyrites, galena, and molybdenite.

Altitude	2,300 feet.
Course of vein	North and south.
Direction of dip	Easterly.
Width of vein	2 feet.
Length of ore shoots, each about	100 feet.
Depth of incline	300 feet.
Vertical depth reached	180 feet.
Formation of foot-wall	Slate.
Formation of hanging-wall	Talcose slate and syenite.
Quantity of water coming in	Small.
Kind of pumps	Bucket pumps, diameter six inches.
Kind of powder used	Giant, No. 2.
Quantity of powder used	275 pounds per month.
Cost of mining	$4 per ton.
Cost of drifts	$3 per foot.
Feet drifted per day in two shifts of ten hours	4
Cost of shaft for labor	$10 per foot.
Feet of shaft sunk per day, three shifts	2
Timbering in drifts	Little.
Cost of timber	Sawed spruce, $18 per thousand feet; round pine, 3½ cents per running foot.
Number of stamps	10
Weight of stamps	750 pounds.
Drop of stamp	6 inches.
Drops	85 per minute.
Duty per stamp	1.7 tons in twenty-four hours.
Kind of shoes and dies	Cast-iron.
Wear of shoes and dies	One set lasts two months.
Kind of screens	No. 6, round punched.
Dimensions of screens	Length, 48 inches; height, 14 inches.
Dimensions of apron (silvered)	48 by 54 inches.
Inclination of apron	1½ inches in one foot.
Width of plated sluices	16 inches.
Length of plated sluices to each battery	16 feet.
Inside plates	None.
Kind and number of feeders	2 box.
Kind and number of concentrators	4 Frue.
Pelton wheels	3
Pelton wheel for pumps	Diameter, 4 feet; water, 14 miner's inches; fall, 110 feet.
Pelton wheel for hoist	Diameter, 8 feet; water, 14 miner's inches; fall, 110 feet.
Pelton wheel for mill	Diameter, 5 feet; water, 40 miner's inches; fall, 125 feet.
Cost of water	10 cents per miner's inch, under 6-inch pressure.

NORTH BANNER MINE.

An extension of the old Banner Mine is situated on Little Deer Creek, at a point two miles southeasterly from Nevada City—altitude three thousand and seventy feet. The property includes two claims, each one thousand five hundred by six hundred feet.

The vein, which has an average thickness of three feet, strikes north 45 degrees west, and dips to the northeast at an angle of 33 degrees. The ore shoot pitches northwest at an angle of 20 degrees, which carries it below the tunnel in a distance of five hundred and twenty-five feet. At the point where the shoot leaves the tunnel, a winze has been sunk thirty

feet, at the bottom of which the vein is said to be three feet wide. From this point in the tunnel an upward incline in the vein on an angle of 10 degrees is being made. This incline is to connect with some old work, and serve the double purpose of an air shaft and a passage for the pipe through which water is to be introduced for driving the wheel. The incline is on the vein; the work of driving it supplies good ore for the mill. The shoot has been stoped above the tunnel to some extent in the past years, but the tunnel is in quite new ground for three hundred feet, with a vertical depth of about two hundred and thirty feet, which gives some four hundred feet on the slope. The total length of the tunnel is one thousand five hundred feet, part being in bedrock. The hanging-wall is syenite, the foot-wall slate. The quantity of water now coming in is moderate, but will probably be greater in the lower levels soon to be opened. The present face of the tunnel being advanced two hundred and seventy-five feet, leaves in the second claim one thousand two hundred and seventy-five feet of new ground to be explored on this level under rising ground, affording a good chance of cutting one or more new pay shoots under the very advantageous conditions of high backs and tunnel outlet. A deeper tunnel is in contemplation. The vein near the surface is in stringers to a great extent, but it consolidates with depth. The ore yields $10 per ton in free gold and nearly an equal amount in sulphurets.

The mine has been worked systematically only for the last year, during which time all the work mentioned has been done except part of the tunnel. Formerly the mine was let to tributers or worked for tenure only. In addition to the work mentioned an upraise is being made from the end of the tunnel to meet a shaft now down one hundred and forty feet. While the vein has required no timbering, some has been found necessary in parts of the tunnel. The cost of mining per ton of ore has not yet been determined. The ore here is quartz, carrying free gold and pyrites, with some galena. It is treated by wet crushing, amalgamation in battery, and on plates; sulphurets which are concentrated amount to about 5 per cent of the weight of ore treated. They have an assay value of $160 per ton, one half to two thirds gold, the remainder silver; they are sold to Selby & Co. The five-stamp mill is located slightly above the tunnel mouth, and will be moved to a lower and more advantageous point and enlarged to ten stamps, as soon as the lower levels of the mine are opened. The Reindeer and the Tinney, two claims lying to the eastward and owned by the same company, have been worked to slight depths by tributers with satisfactory results, the developments being but trifling.

Altitude	3,070 feet.
Length of ore shoot	525 feet.
Vertical depth from surface reached in tunnel	230 feet.
Vertical depth reached by winze	30 feet.
Average width of vein	3 feet.
Hanging-wall	Syenite.
Foot-wall	Slate.
Ore	Quartz, pyrites, galena, tetrahedrite, etc.
Number of stamps	5
Weight of stamp	1,000 pounds.
Drop of stamps	6 to 7 inches.
Drops of stamp	80 per minute.
Duty of stamp	2 tons in twenty-four hours.
Kind of shoes and dies	Cast iron.
Kind of screens	Round punched, No. 4.
Dimensions of apron	Width, 5 feet; length, 4 feet.
Width of plated sluices	20 inches.
Length of plated sluices	10 feet.
Kind and number of feeders	Box; 1.
Kind and number of concentrators	Triumph; 2.
Percentage of recovery saved in mortar	67

Percentage of recovery saved on plates	33
Value of bullion in gold	$10 per ounce.
Percentage of sulphurets	5
Value of sulphurets	$160 per ton.
Cost of milling	75 cents per ton.
Number of men in mine	17
Number of men in mill	2
Wages in mine	$3 per day.
Wages in mill	$2 50 per day.
Water used for power	35 miner's inches.
Fall of water used for power	75 feet.
Kind of water wheel used for power	Pelton.
Cost of water used for power	16 cents per miner's inch.

A characteristic feature of the mines in and about Banner Hill is the presence of a considerable amount of silver in the ores.

PIONEER REDUCTION WORKS.

These well known works are situated about three quarters of a mile southwest of Nevada City, near to the Grass Valley road. They were started December 8, 1858, and have been in operation ever since, having in the interim treated sixteen thousand eight hundred tons of concentrates. Last year one thousand and eighty-nine tons were handled, being an increase over any previous similar length of time since the works were built. The average value of the material treated has been $80 per ton, of which Mr. Maltman, the owner, states 94 per cent has been extracted. The roasting furnaces, two in number, are of the kind known as the long reverberatory—one being fifty and the other sixty feet in length. The first hearth in each is sixteen feet long by twelve feet wide, the other hearths having a width of ten feet. These furnaces have a joint capacity of five tons in twenty-four hours, with a consumption of three eighths of a cord of wood per ton. The fuel is mostly pine and cedar, costing an average of $4 40 per cord. At present the works employ five men at $2 50 per day each; when running to the full capacity, nine men are required. The furnaces are in a separate building, the roasted ore being carried to the leaching house, five hundred feet distant, by means of an iron car and tramway. There are nine gassing tubs, each five feet six inches in diameter by four feet four inches deep in the clear, with an average capacity of three thousand five hundred pounds of ore each. There is also a set of nine leaching vats for silver, to which ore containing that metal is transferred after the gold leaching, and is then treated by the "Kiss" process for the silver. These silver vats are three by four by five feet in size. The precipitating vats for gold, of which there are four, are thirty inches deep and eight feet in diameter; there are two similar precipitating tubs for silver.

The concentrates are usually bought, but little custom work being done. The charge for custom work, in small lots, is $18 per ton. The purchasing price is usually 92 per cent of the gold assaying value, no allowance being made for the silver unless the value in that metal exceeds $10 per ton, when 60 per cent is given. The charge for working is deducted, so that, in fact, the transaction amounts to exactly the same thing as custom work, at a fixed price with a guaranteed percentage extraction. The percentage is calculated on the assay of the raw material, hence any loss sustained in the roasting, etc., falls on the purchaser. A charge is drawn from the first hearth of a furnace every seventh hour, which gives the ore over twenty-four hours' roasting altogether. The roasted ore is in chlorine thirty-six hours before the leaching begins. The gold is precipitated in the usual way by sulphate of iron.

CHLORINATION WORKS OF THE MERRIFIELD MINE.

These works, which are leased to Mr. H. Stansfield, are situated at the Merrifield Mine on Deer Creek, about a mile west of Nevada City. The lessee buys concentrated sulphurets from the various mills, paying from 85 to 90 per cent of the result of sample assay. He roasts the ore before taking the sample for assay, in order to protect himself in case there be a loss of gold in the roasting, which he thinks always occurs to a greater or less extent. His charge for custom work is $18 per ton. These works consist of a reverberatory roasting furnace, seventy feet in length by ten feet wide inside, and having a roasting capacity for three tons of concentrates per twenty-four hours, with a consumption of three fourths of a cord of wood to the ton. The works contain two chlorine generators; four "gassing tubs" (chlorinating vats), three precipitating tubs for gold, three for silver, and other usual implements and apparatus. The dimensions of the "gassing tubs" are: diameter six feet eight inches, depth two feet six inches inside, with a capacity for three tons of ore. The precipitating vats for gold have a diameter of six feet, and a depth of three feet; those for silver being of like dimensions. The leaching tubs for silver are similar to the "gassing tubs." The vats are coated with a mixture of asphalt and coal-tar, in the manner first introduced by G. F. Deetkin, M.E., and once the subject of a patent long since expired. Red fireproof paint is used for the inside of the vat covers, this protecting the wood from the action of the chlorine perfectly. The filters are simply perforated boards covered with burlap.

After the gold has been leached out, the ore, if it contains silver, is transferred to the silver leaching tubs, where it is leached with calcium "hypo" for the silver. The latter, after being thus extracted, is precipitated as silver sulphide in the precipitating tubs, by stirring in a solution of calcium polysulphide. On the sides of the silver precipitating tubs a thick black crystalline crust has formed, which contains a large proportion of silver, it being probably gypsum and silver sulphide.

The chlorine generators are of the pattern formerly used by Professor Crosby, at Nevada City, being without stirrers. They stand in a slightly inclined position, so that the bottoms slope downward from the point of ingress of the acid. A water bath is used for heating the generators, it being preferable to a hot plate, as it prevents too high a degree of heat, which causes the solid in the generator to form a hard crust, troublesome to remove. The tops of the generators are of the flat style, luted in a flange. They very seldom require to be raised, as, by avoidance of too high heat, the exhausted charge is readily removed by means of a stream of water, through the spout in the side, which passes through the wall of the iron pan forming the water bath. For the eduction of the chlorine there is a short, wide standpipe in the cover, in the upper end of which is fitted a plug of lead carrying the eduction pipe, also of lead. Another similar arrangement carries the S tube by which acid is introduced, this being made wide enough to serve also, on removing the plug, for the introduction of the charge of manganese and salt. Sulphuric acid is bought in iron tanks, which effects a saving in freight and breakage, as compared with carboys. The ore is exposed to the action of chlorine during forty-eight hours. The gold is precipitated from the leach by solution of sulphate of iron.

Dimensions of roasting furnace, inside	70 by 10 feet.
Capacity of roasting furnace	3 tons in twenty-four hours.
Consumption of wood for roasting 1 ton	Three fourths of a cord.

Number of gassing tubs	4
Number of gold precipitating tubs	3
Number of silver leaching tubs	3
Number of silver precipitating tubs	3
Dimensions of gassing tubs, inside diameter	80 inches.
Dimensions of gassing tubs, inside depth	30 inches.
Capacity of gassing tubs	3 tons.
Dimensions of precipitating tub, inside diameter	72 inches.
Dimensions of precipitating tub, inside depth	36 inches.
Time of charge in chlorine	48 hours.
Consumption of chemicals to 1 ton of ore	Manganese, 6 pounds; salt in furnace, 40 pounds; salt in generator, 6 pounds; sulphuric acid of 66 degrees B., 20 pounds.

Mr. Stansfield has observed in some cases a heavy loss of gold in roasting in the muffle without salt. In one case this amounted to 25 per cent of the result obtained by direct assay of the raw ore, but in all cases there is some loss. The causes would be a very interesting matter for investigation. It has been known to metallurgists that a heavy loss of gold by volatilization may occur in the roasting of some auriferous sulphurets with an addition of salt. This was discovered by C. H. Aaron, and remarked on in his "Hand-book on Leaching Gold and Silver Ores," published in 1881, the fact having been rediscovered by C. A. Stetefeldt several years later. Stetefeldt attributes the loss to the presence of cuprous chloride in the roasting ore, resulting from copper pyrites under the action of the salt. Other metallurgists dispute this explanation, saying that they have had a different experience. Certain it is that concentrated pyrites have often been roasted with as much as 5 per cent of salt added to the raw ore without any loss, or any considerable loss of gold; equally certain that in other cases the addition of 2 per cent of salt at an early stage in the roasting has caused a heavy loss, not alone in muffle experiments, but in practical work.

Ever since Deetkin, in 1866, introduced the use of salt in the roasting of auriferous pyrites, on account of the presence of talc in the sulphurets of the Eureka Mine, the practice has been followed in all cases by operators in this vicinity, whether the material contained talc, or silver, or neither of those substances, as the use of a little salt was found to reduce the consumption of chlorine in the gassing tubs. The practice was to mix the salt with the raw charge, a method necessary, perhaps, when talc is present, but, just as in 1866 the sudden appearance of talcose matter in the Eureka sulphurets, which up to that time had been treated successfully without salt, baffled the local operators of that day until Deetkin's discovery; so, about 1878, the sulphurets from the Murchie Mine, to which salt was added in the then usual manner, not only as a safeguard against the possible presence of magnesian compounds, but as a matter of necessity on account of the silver in the ore, offered at once a stumbling block and a revelation, in that a large percentage of the gold went up the chimney. This time it was Aaron who came to the rescue, he showing that the loss of gold could be avoided, and the silver chloridized by reserving the salt until the dead roasting is completed, then adding it, after lowering the temperature of the furnace, and withdrawing the charge within twenty minutes.

The announcement of the volatility of gold in roasting was at first received with incredulity, except by those who had tried to work the Murchie sulphurets. To-day every operator on this coast is on his guard in this respect. Thus it is that while the purely practical man may succeed very well while following a beaten road, he is compelled, when the road forks or becomes obscure, to apply to science for direction and guidance.

Mr. Stansfield declares that there is a loss, and may be a heavy loss, of gold in the roasting of sulphurets in the absence of salt, and that the loss is not merely mechanical, as by decrepitation, etc. It may be that Mr. Stansfield has roasted too rapidly, which is always dangerous in a reverberatory furnace, and it may be that some of the ores treated by him contained tellurium, another cause of trouble when present.

GRASS VALLEY DISTRICT.

IDAHO MINE.

This mine, situated one mile south from the town of Grass Valley, has had a long and successful history, having produced a total of over $8,000,000, nearly one half of which has been disbursed to the shareholders in dividends, the payment of which commencing in 1869 has since been intermitted for a period of only five months. A tolerably full description of this mine and plant, with the methods of extracting and treatment of the ore here, having been given in the report of the State Mineralogist for 1886, Part II, it will not at this time be necessary to say more, except in increased depth of working, no notable change having been effected in the mine for the past two years. The present total depth of the incline is two thousand six hundred and ninety-six feet, vertical depth one thousand seven hundred and ninety feet. The average width of the vein in the lower workings—length of ore shoot one thousand two hundred feet—is given at thirty inches. In the year 1887 there were crushed here twenty-six thousand six hundred and eighty-six tons of rock. The water raised daily by the Cornish plunger pumps amounts to twenty-one thousand six hundred cubic feet. The mine employs one hundred and seventy-three men and the mill seventeen, while sixteen are occupied on outside work. The wages paid are $3 a day for men in the mine and mill, and from $3 to $5 on outside work. The cost of powder (Safety Nitro) and fuse in 1887 was $8,687 68; of steel for drills, $605 52. Mining and milling per ton of ore cost $8 44. The screens have been changed from No. 5 slot to No. 6 slot. The mill, of thirty-five stamps, uses thirty miner's inches of water (six-inch pressure), and three hundred and twenty miner's inches are required under a pressure of five hundred and forty-two feet to drive the Pelton wheels, of which there are three of eight-foot diameter, four of six-foot, one of five-foot, one of three-foot, two of eighteen-inch, and one of nine-inch.

The pitch of the vein is southerly from 73 degrees to 55 degrees, the course being nearly east and west. The pay shoot pitches easterly at an angle of about 40 degrees. This agrees with the theory of some in this section, that as a rule, the pay shoot here always pitches to the *left* of the observer, standing on the foot-wall and facing the vein. Whether this rule is general or not, it seems to hold good in a considerable number of cases.

The tailings from the mill are being re-treated by Messrs. Cobb & Norton, by being passed, with additional clean water, through shallow sluices or strakes, lined with canvas, to which the *fine* sulphurets cling and are washed off periodically by means of a jet from a hose and nozzle, and being afterwards collected, they are further cleansed by a repetition of the process. The resulting concentrated material is worth $30 per ton and upward.

Below, on the creek, the tailings from Cobb & Norton's works are taken up by Bush & Gauthier, who pass them through sizing boxes, and again over strakes lined with gunny sacks, which are periodically lifted and washed in tanks. The coarse sulphurets lost above being thus recovered, are mixed with sand and treated by grinding and amalgamation in eight

Knox pans, driven by a small overshot wheel. In these pans, besides quicksilver, nitrate of mercury and sometimes bluestone are used, the operators being of the opinion that they get nearly all of the gold. The eight pans work one and one half tons of the stuff in twenty-four hours. A part of the gold obtained by this latter process comes, no doubt, from the coarse sand, in the grains of which it is inclosed. The nitrate of mercury probably acts by precipitating a film of mercury upon the iron surface of the pan and upon each particle of iron ground off from the shoes and dies. The mercury *in statu nascendi* probably tends, without extra energy, to attach itself to the liberated particles of gold. The bluestone, in all probability, assists in the formation of an amalgamated film on the iron, by coating it with copper; but as it is used only occasionally, and for the purpose of preventing a large loss of mercury, under certain conditions, its principal use seems to be to dissolve such particles of iron as have become amalgamated through the action of nitrate of mercury, and thus produce a powdery sort of amalgam, which, when the iron is replaced by copper from the bluestone, is converted into a soft, coherent amalgam, easily saved in the washing.

The Idaho Mill is provided with an extensive system of strakes, over which the tailings are first passed, after leaving the mill, where they have already flowed over the blankets, so that all the ore is subjected to no less than four concentrations. But, after all, these tailings are probably not much poorer than they would be if treated in the modern way, by amalgamation in the battery and on plates and concentrated on Frue or Triumph vanners.

Altitude	2,450 feet.
Present vertical depth reached	1,790 feet.
Present depth reached on incline	2,696 feet.
Length of ore shoot	1,200 feet.
Quantity of water raised in twenty-four hours	21,600 cubic feet.
Cost of powder and fuse for 1887	$8,687 68
Cost of steel for drills for 1887	$605 52
Cost of mining and milling	$8 44 per ton.
Quantity of ore crushed in 1887	26,686 tons.
Number of stamps	35
Weight of stamps	850 pounds.
Drop of stamp	9.5 inches.
Drops of stamp	72 per minute.
Kind of screen	No. 6, slot.
Concentrators	Blankets; Cornish buddle.
Water used in battery	30 miner's inches.
Water used for power	320 miner's inches.
Fall of water for power	542 feet.
Kind of wheels used for power	Pelton.

ORIGINAL EMPIRE GOLD QUARTZ MINE.

Located in 1850, one mile southeast of the City of Grass Valley, at an altitude of two thousand eight hundred feet. The property has a length of five thousand feet and a breadth of seven hundred and fifty feet, being a consolidation of several claims.

There are several veins with a northwest and southeast course, and a westerly dip of about 30 degrees. The length of the ore shoots varies from six hundred and fifty feet in the Rich Hill ledge to one thousand eight hundred feet in the Ophir ledge.

The mine is opened by two inclined shafts to a depth of one thousand seven hundred feet on the incline, or seven hundred and fifty feet vertically. The foot-wall vein is in diabase, the hanging-wall vein is in diorite and diabase. About eighteen thousand gallons of water are raised per

hour by a Cornish plunger pump. A compressor from the Risdon Iron Works and a National drill, together with Giant powder, are used in drifting and sinking. The cost of drifting is from $3 50 to $6 per foot; of sinking, $25 to $35 per foot, and of mining, dead work, etc., included, is $5 per ton. The distance from the mine to the timber is from two to five miles.

The ore is a quartz gangue, carrying free gold and auriferous sulphurets, and is treated by wet stamping, amalgamation, and concentration, in a mill of forty stamps, each stamp weighing eight hundred and fifty pounds, dropping seven inches ninety times per minute, and crushing two tons of ore in each twenty-four hours, through brass wire screens of thirty meshes to the linear inch, and forty-eight inches by twelve inches clear surface. The screens are inclined.

The battery shoes and dies are of chrome steel, costing 9 cents per pound. Each battery has a length of twenty-five feet of silvered plates, sixteen inches wide, inclining from one and one fourth to one and three fourths inches per foot; also inside plates forty-eight inches long by five inches wide. Of the gold saved, from 75 to 85 per cent is found in the mortars, and one ounce of quicksilver is lost for each ton of ore worked. The tailings are passed over sixteen Triumph concentrators, each of which requires from one to one and a half gallons of feed-water per minute (in addition to that from the batteries). The concentrates amount to 2½ per cent of the weight of ore crushed, and consist of iron pyrites with a little galena, having an assay value of $120 to $200 per ton. They are disposed of by sale to the highest bidder.

The mill, hoisting works, etc., are driven by water, conveyed a distance of one thousand three hundred feet from the company's reservoir, in a twenty-two-inch pipe. The mill uses eighty miner's inches of water under a pressure of four hundred and forty feet. The pump, compressor, and hoisting works use one hundred and fifty miner's inches under four hundred and twenty-two feet. The water is measured under six-inch pressure and costs 14 cents per inch per twenty-four hours. The mill employs seven men, the mine from one hundred and twenty to one hundred and sixty, and eight are occupied on outside work.

Altitude	2,800 feet.
Length of ore shoots	650 to 1,800 feet.
Length of ore shaft on incline	1,700 feet.
Vertical depth reached	750 feet.
Quantity of water raised per hour	18,000 gallons.
Character of walls	Hanging, diorite; foot, diabase.
Kind of compressor used	Risdon Iron Works.
Kind of drill used	National.
Kind of powder used	Giant.
Cost per foot of shaft	$25 to $35
Cost of mining per ton, including dead work, etc.	$5
Number of stamps	40
Weight of stamp, each	850 pounds.
Drop of stamps	7 inches.
Drop of each stamp per minute	90
Duty of each stamp in twenty-four hours	2 tons.
Kind of shoes and dies	Chrome steel.
Cost of shoes and dies, about	9 cents per pound.
Width of amalgamated plates	16 inches.
Length of amalgamated plates to each battery	25 feet.
Size of inside battery plates	5 by 48 inches.
Kind and grade of screens	Brass wire, 30-mesh.
Discharge surface of screens	12 by 48 inches.
Recovery of gold, percentage saved in mortars	75 to 85
Recovery of gold, percentage saved on plates	15 to 25
Kind of rock breaker	Blake.
Number of rock breakers	3
Kind of feeders	Challenge.

Number of feeders	8
Kind of concentrators	Triumph.
Number of concentrators	16
Concentrators—water fed to each per minute	1 to 1½ gallons.
Percentage of sulphurets	2¼
Description of sulphurets	Pyrites, galena.
Value of sulphurets	$120 to $200 per ton.
Loss of quicksilver per ton of ore	1 pound.
Water used for power in mill	80 miner's inches.
Pressure of water used for power in mill	422 feet.
Water used for power in hoisting works; Water used for power in compressor; Water used for power in pump	150 miner's inches; pressure of 440 feet.
Cost of water per miner's inch, under six inches pressure	14 cents.
Number of men employed in mill	7
Number of men employed in mine	120 to 160
Number of men employed outside	8
Wages paid per day in mine	$3
Wages paid amalgamators per month	$90
Wages paid concentrators per shift	$2 50 to $3
Wages paid rock breakers per shift	$2 50

NORTH STAR GOLD QUARTZ MINE.

This mine is situated two miles south of Grass Valley, at an altitude of two thousand four hundred feet. The dimensions of the claim are three thousand two hundred feet by eight hundred feet. The course of the vein is east and west, with a northerly dip of 26 degrees, and an average width of two feet. The aggregate length of ore shoots is two thousand feet, and the mine is worked by an inclined shaft of one thousand and seven hundred feet to a vertical depth of five hundred and fifty feet. The walls are diabase. Water to the amount of fifteen thousand gallons per hour is raised by a Cornish plunger pump. Sinking costs $20 per foot, and ore, including dead work, is extracted at an expense of $5 per ton. The work is carried on by the aid of a Risdon Iron Works compressor, National drill, and Giant powder.

The ore is quartz, with free gold, pyrites, and a little galena, and is treated by wet crushing, amalgamation, and concentration. The mill has thirty stamps, with ten additional being erected, each of which weighs eight hundred and fifty pounds, drops seven inches at the rate of from eighty-five to ninety times per minute, and crushes two tons of ore in twenty-four hours. The shoes and dies are of chrome steel, costing about nine cents per pound. The quantity of water used for the stamps is seven inches for six batteries. The screens are of thirty-mesh brass wire gauze, with a surface of twelve by forty-eight inches clear, and are inclined. The aprons are silvered, and are four feet wide by six feet long. The sluice plates (silvered) are four feet wide and twenty feet long, and have an inclination of from one and one quarter to one and three quarters inches per foot; the inside plates are five by forty-eight inches. Challenge feeders are used, one to each battery of five stamps, or six in all. The sulphurets, with an assay value of from $65 to $100 per ton, consisting of iron pyrites chiefly, and amounting to 3½ per cent of the ore, are saved by Triumph concentrators and sold. The mill, compressor, hoisting works, and pump are driven by three hundred and twelve miner's inches of water, under from two hundred and thirty-two to two hundred and eighty-two feet fall, costing 14 cents per inch, measured under six-inch pressure.

Altitude	2,400 feet.
Length of ore shoot	2,000 feet.
Length of ore shaft on incline	1,700 feet.
Vertical depth reached	550 feet.
Quantity of water raised per hour	17,000 gallons.

Character of walls	Both diabase.
Kind of compressors used	Risdon Iron Works.
Kind of drill used	National.
Kind of powder used	Giant.
Cost of shaft	$20 per foot.
Cost of mining, including dead work, etc.	$5 per ton.
Number of stamps	30
Weight of stamps	850 pounds each.
Drop of stamps	7 inches.
Drop of each stamp	85 to 90 per minute.
Duty of each stamp	2 tons in twenty-four hours.
Kind of shoes and dies	Chrome steel.
Cost of shoes and dies	About 9 cents a pound.
Dimensions of aprons (silvered)	4 by 6 feet.
Dimensions of sluice plates	4 by 20 feet.
Inclination of sluice plates per foot	1¼ to 1½ inches.
Size of inside plates	5 by 48 inches.
Kind and grade of screens	30-mesh, brass wire.
Discharge surface of screens	12 by 48 inches.
Recovery of gold in mortars	80 per cent.
Recovery of gold on plates	20 per cent.
Kind of feeders	Challenge.
Number of feeders	6
Kind of concentrators	Triumph.
Concentrators at present in use	12. Four additional being erected.
Sulphurets	20 per cent.
Description of sulphurets	Iron pyrite.
Value of sulphurets	$65 to $100 per ton.
Water used for power	312 miner's inches.
Fall of water used for power	232 to 282 feet.
Cost of water per miner's inch, under six-inch pressure	14 cents.
Number of men employed in mine	150 to 170.
Number of men employed in mill	6
Number of men employed on outside work	8

CROWN POINT MINE.

This mine, owned solely by Mr. A. Gauthier, is situated in the easterly outskirts of the town of Grass Valley, at an altitude of two thousand four hundred and forty-seven feet. The vein has an east and west course with a northerly dip of 70 degrees; average thickness, seven feet; length of pay shoot, two hundred and ninety feet. The hanging-wall is slate; the foot-wall serpentine. The ore is quartz, carrying free gold, galena, and pyrites. Portions of this quartz are mixed with serpentine, some pieces being very rich, which appeared at first sight like worthless rock of that kind. The cost of ore extraction is $10 per ton. This mine is worked through an incline shaft, with a depth on the incline of three hundred feet. The water amounting to about three inches is raised by a six-inch Cornish pump. A larger pump will be put in soon. The entire mine is timbered with spruce in the drifts and pine in the stopes. Timber costs from 6 to 10 cents per running foot. The developments as given are: three hundred-foot level, one hundred and seventy feet; one hundred and eighty-foot level, six hundred feet one way and two hundred and twenty feet the other.

The mill located at the mouth of the shaft has ten stamps of seven hundred and fifty pounds each, dropping eight inches seventy-five times per minute, crushing one and a half tons of ore per stamp in each twenty-four hours through a No. 30 wire screen with a surface of four and a half feet by one foot placed vertically, the feeders being Hendy's Challenge. Steel shoes and dies, costing 10 cents per pound in San Francisco, are in use. Quicksilver is used in the battery, also on inside front plate of copper four feet by five inches. One of the two five-stamp batteries is furnished with a silver-plated apron four feet by three feet in size, with an inclination of three quarters of an inch to the foot, and eight feet of plated sluice fifteen inches wide. The other battery is provided with a shaking amalgam

table, invented by Mr. Gauthier, which will probably supersede entirely the apron now used in gold mills. The invention consists of a silvered copper-plated table as wide as the discharge of the mortar, and sixteen feet long, mounted on vibrating standards precisely as the Triumph concentrator, and having a similar "end shake" or longitudinal oscillation imparted to it by means of a shaft and eccentric below. The amplitude of the vibrations is adjustable, but is usually set at one and a half inches. This table, which occupies the position of the ordinary apron, receives the pulp from the mortar and has a slight inclination downward from the battery, much less, however, than is necessary in a fixed apron, because the shaking keeps the sand in a loose and open condition independently of the current water. For the same reason, also, less water is required than with the usual arrangements.

The shaking amalgam table must commend itself to every thinking operator as a thing that cannot do harm, and which seemingly performs a useful service. The claims of this machine do not, in fact, rest solely on theory. In a first experiment this plated table was mounted on the top of a Triumph concentrator, receiving the pulp after it had passed over the usual apron and plated sluices, and it was found that 7 per cent of the total gold was saved on the table. The load proving too heavy for the Triumph machine to carry, the shaking table was mounted separately, to the end that direct comparison of results with those obtained from the apron and sluices of the other battery might be reached. The value of the shaking amalgam table is further confirmed by the experience made in the North Star Mill, where one of them, placed between the plated sluices and the concentrators, saves $50 worth of amalgam per day, as stated by J. H. Hammond, E.M. Facts and theory combine to induce the belief that the shaking amalgam table is a valuable addition to our metallurgical appliances.

Two Triumph concentrators have been placed in this mill for the collection of sulphurets, of which there are 2 per cent with a value of $60 per ton gold. Mr. Gauthier states that his ore yields $17 per ton in free gold, worth from $16 95 to $17 20 per ounce. The water used for power, for both mill and mine, is costing 5 cents per miner's inch, taken second hand from the Idaho Mill. The Crown Point Mill is driven by one Pelton wheel, the hoisting being done by another. The two use sixty miner's inches of water, an overshot with a like quantity being used for pumping. The mine employs fifteen men at $3 per day, and the mill four men at $2 75 per day.

Altitude	2,447 feet.
Depth of incline (70 degrees)	300 feet.
Length of pay shoot	290 feet.
Width of vein	7 feet.
Number of stamps	10
Weight of stamps	750 pounds each.
Drop of stamp	8 inches.
Drops of stamp	75 per minute.
Duty of stamps	15 tons in twenty-four hours.
Kind of screens used	Wire, No. 30.
Dimensions of screens	Length, 53 inches; height, 12 inches.
Percentage of recovery saved in batteries	50
Percentage of gold saved on plates	50
Cost of mining	$10 per ton.
Cost of timber	6 to 10 cents per running foot.
Water used for power	120 miner's inches.
Cost of water (second hand)	5 cents per miner's inch.
Dimensions of apron	Length, 4 feet; width, 3 feet.
Dimensions of shaking amalgam table	Length, 16 feet; width, 4 feet.
Kind and number of concentrators used	Triumph, 2.
Value of sulphurets in ore	$60 per ton.
Percentage of sulphurets in ore	2

Number of men in mine	15
Number of men in mill	4
Wages in mine	$3 per day.
Wages in mill	$2 75 per day.
Wear of shoes and dies	Not given.

BRUNSWICK MINE.

This mine, an early location, is situated two miles east of the town of Grass Valley. The present owners, an incorporated company, having recently purchased the property, have since equipped it with a twenty-stamp mill and hoisting works. Some two hundred tons of ore have already been taken out and ore extraction will proceed rapidly as soon as the drifts now being driven are further advanced. The hoisting works are well constructed, with blacksmith shop and changing room under the same roof. These works are driven by an eight-foot Pelton wheel, with two nozzles, twenty-five inches of water under two hundred and eighty-foot pressure. The mill, formerly arranged for blanket sluices only, is now being fitted with copper plates, etc.

After working a certain quantity of ore this mill is to be entirely renovated and water power applied to drive it. When this alteration has been effected the steam engine now in the mill, which has a twenty-inch cylinder and three-foot stroke, will be removed to the hoisting works, to be used there in case of any water deficiency. Placed in these works is an eight-inch lift pump, though the mine makes but little water at present. The claim is two thousand nine hundred feet long, and contains thirty-seven acres patented. The vein has been worked in the past to a depth of sixty feet in places, along a length of eighteen hundred feet. The course of the vein is northwest and southeast, with a southwesterly dip of 41 degrees. Average width, two feet. The walls are slate, as is also the general country rock. Present developments consist of a drain tunnel five hundred feet in length, reaching a depth of two hundred feet on the dip; an inclined shaft three hundred and twenty feet long; a level, No. 1, five hundred feet long, and a level, No. 2, extending four hundred and eighty-five feet southeasterly and four hundred and twenty-five feet northwesterly from the shaft, which latter extends thirty-five feet below the second level. The ground to the east of the shaft has been extensively stoped; little stoping has, however, been done to the westward, except above the first level. The ore consists of common quartz, with free gold, and a small percentage of pyrites, galena, and blende. The mill being on the mine there is no expense for transportation of ore.

The company employs sixteen men, at $3 per day for miners, $2 50 for carmen, etc. The cost of mining is $2 50 per ton; drifting is contracted for at $1 75 per foot. Powder used, Safety Nitro, costing 16 cents per pound. The shaft cost $7 per foot without tracks, etc., $9 per foot completed; it is in three compartments, aggregating a width of twelve feet. The entire shaft is timbered with pine and spruce; in the levels but little timber is required. Timber is obtained on the property.

The mill contains a Blake rock breaker, twenty stamps, of nine hundred and fifty pounds each, a clean-up pan, and two Atwood amalgamators; latter not in use.

Altitude	2,680 feet.
Length of shaft on incline	320 feet.
Length of drain tunnel	500 feet.
Total length of drifts	1,410 feet.
Cost of mining	$2 50 per ton.
Cost of drift	$1 75 per foot.

Cost of shaft	$9 per foot.
Miners wages	$3 per day.
Number of stamps	20
Weight of stamp	950 pounds.

ORLEANS MINE

Is situated one and one half miles southeast of Grass Valley, at an altitude of two thousand six hundred and seventy-seven feet. The claim, an original south extension of the Empire, is three thousand by six hundred feet. The vein is split into a number of stringers, and the walls are irregular. The mine is worked through an inclined shaft, having a depth of six hundred feet on the slope, and reaching three hundred and twenty feet vertically. A large quantity of water comes in, which is raised to a drain tunnel two thousand feet long by a Cornish lift-pump of eight inches diameter, making ten four-foot strokes per minute. The shaft and tunnel are timbered throughout with spruce and pine. The ore is quartz with free gold, and a small percentage of pyrites, blende, and galena.

Developments in the mine consist of four working levels, the drain tunnel being the first; the third, fourth, and fifth have the respective lengths of seven hundred, three hundred, and four hundred feet. The second level has not been worked to any great extent. Above the drain tunnel the mine was worked out long ago, and paid well. The company employs twelve men at $2 50 per day. For pumping there is a sixty-horse power steam engine, and another of about fifteen-horse power for hoisting. Pine wood at $3 per cord is used for making steam, two cords being required daily.

The mill, driven by steam power, contains eight stamps of nine hundred pounds each, dropping from ten to twelve inches sixty times per minute, and crushing two and five tenths tons of very hard rock per stamp in twenty-four hours, through a slot-punched screen, aperture two one hundredths inch wide by five tenths inch long, screens set vertically. The shoes and dies are of white iron, costing 4½ cents per pound at the local foundry. The mill, which is twenty-five years old, is of ancient style, the stem and stampheads being square, the tappets faced with wood, and the cams having each three arms.

The Superintendent, Mr. John L. Smith, is of the opinion that this mill, while it requires more power for running it than the modern mill, will crush nearly or quite as much ore as the latter for the power used, the duty given being that for extra hard rock. No satisfactory comparison can, however, be made unless two batteries, representing different styles, are worked on precisely similar rock, and under otherwise similar conditions. In this mill there is no amalgamation in battery nor on plates, the pulp flowing from the mortars directly to blanket sluices, of which each mortar has four, each being twelve feet in length. These blankets are washed at stated intervals, and the material thus obtained is treated with quicksilver in an Atwood amalgamator, and in two Knox pans. The pulp passing from the sluices flows into a set of ripple sluices, from which the accumulated heavy matter is removed periodically and cleaned in a rocker. The pulp or tailings from rockers, pans, etc., is finally passed through blanket sluices, which retain the sulphurets, amounting to 3 per cent of the ore crushed, and having a value of about $60 per ton. The concentrates are sold.

Altitude	2,677 feet.
Length of ore shaft on incline	600 feet.
Vertical depth reached by ore shaft	320 feet.
Number of stamps	8
Weight of stamps	900 pounds each.

Drop of stamp	10 to 12 inches.
Drops of stamp	60 per minute.
Duty of stamp	2.5 tons in twenty-four hours.
Size of aperture in screens	0.02 inch by 0.5 inch.
Percentage of sulphurets	3
Value of sulphurets	$60 per ton.
Number of men in mine	12
Wages paid in mine	$2 50 per day.
Cost of wood	$3 per cord.

GREEN MOUNTAIN MINE,

Situated about one thousand two hundred feet south of the Orleans and on the same vein, has yielded good ore in the past. Hoisting works are now being put up on this ground.

ROCKY BAR MINE,

An early location in this district, is situated on New York Hill, two miles south of Grass Valley, at an altitude of two thousand four hundred and ninety-seven feet. The claim, one thousand six hundred feet in length, covers two parallel east and west veins, the one dipping south and the other north, the average thickness of each being about one foot. The north dipping vein has been opened by an inclined shaft to a depth of six hundred feet, the other by a similar shaft to a depth of four hundred feet, each of these shafts being supplied with steam power hoisting works. There is a ten-stamp steam quartz mill on the premises, not now running. The little water made by the mine, which occurs in slate, is drained by the New York Hill tunnel.

Altitude	2,497 feet.
Depth of inclines	600 and 400 feet.
Width of veins	1 foot.
Number of stamps	10
Number of men employed in mine	15

OMAHA CONSOLIDATED MINE.

This property is situated one and a half miles south from Grass Valley. The claim, a consolidation of the Omaha and the Lone Jack, covers a length of two thousand five hundred feet. The vein, which courses north and south, has a westerly dip of 36 degrees down to the seventh level, and of 45 degrees from that to the tenth level. It has, so far as exposed, an average thickness of one foot, being much thicker in places. The ore is quartz with free gold, pyrites, blende, and galena. It is the general opinion here of miners that the presence of sulphurets, especially galena and "black Jack," indicates good ore in the district. The country rock and wall are granitic south of the shaft, and slate to the north. The slate appears to cut under the granite and will probably constitute the only country rock at greater depth.

This mine is worked from an incline shaft down six hundred and sixty feet on the dip of the vein. A shaft is being sunk on the Lone Jack, which will afford ventilation when connected with that on the Omaha. But little timber has been required. The present company during the last five months advanced the seventh level north one hundred feet; the eighth level two hundred feet, and the tenth one hundred and twenty-five feet. Above the seventh the mine was worked long ago, but had recently been given to tributers. Some very rich rock has lately been taken from the fifth level. The tenth level will be continued to the northward, and the mill is to be

enlarged and furnished with Frue vanners. The percentage of sulphurets is not yet known; the value of those tested was $100 per ton in gold.

The present mill has ten stamps weighing nine hundred pounds each, dropping seven inches eighty times per minute, with a duty of one and six tenths tons per stamp in twenty-four hours, crushed through a No. 6 slot punched screen, the battery being fed by a Hendy Challenge feeder. The pulp flows over aprons four feet wide by eighteen inches long, and sluice plates eighteen inches wide by twenty feet long to each battery; also, back plates, four feet by four inches, in the mortar. The plates are silvered, and the sulphurets are saved on four Hendy concentrators. A Knox pan is used for cleaning up. The mill stands adjacent to the mine.

The wages paid in the mine are $3 per day; in the mill, $2 75; for outside work, $2 50. The mill is driven by a thirty-six-foot overshot wheel. An eleven-foot Pelton wheel does the pumping, and a six-foot Pelton the hoisting, both under fifty-five feet of pressure. Cost of water for all purposes, $50 per month. The mine water (about twenty-five miner's inches) is raised by two pole pumps, the upper having a diameter of twelve, and the lower of ten inches, with a six-foot stroke; six strokes per minute. Powder used, Hercules, No. 2. Both iron and steel are used for shoes and dies.

Altitude	2,287 feet.
Length of ore shaft on incline	660 feet.
Water raised from mine	25 miner's inches.
Number of stamps	10
Weight of stamps	900 pounds each.
Drop of stamps	7 inches.
Drops of stamp	80 per minute.
Duty of stamps	1.6 tons in twenty-four hours.
Number and kind of feeders used	2 Hendy.
Kind of screens used	Slot punched, No. 6.
Dimensions of aprons	Length, 18 inches; width, 4 feet.
Width of plated sluices	18 inches.
Length of plated sluices to each battery	20 feet.
Number of men in mine	50
Number of men in mill	4
Total number employed	60
Wages in mine	$2 75 per day.
Wages in mill	$3 per day.
Miner's inches of water used	Not given.
Cost of water for all purposes	$50 per month.

SPRING HILL MINE

Is situated one mile east of the town of Grass Valley, near the Idaho, the two lodes being nearly parallel, though they dip in opposite directions. The Spring Hill claim, including its east extension, embraces one thousand two hundred and twenty-five and eighty-two one hundredths feet on the line of the lode; area of claim, forty acres, which includes a mill site. The course of the vein, which is traceable throughout the length of the claim, is south 80 degrees west; dip, north at about 40 degrees.

The vein, which varies in thickness from two to three feet, has been opened at various points and at different times—in two places to a depth of one hundred and eighty feet. Several lots of ore have been milled with results certified as follows: August 3, 1870, ten loads, $74; August 27, 1870, eight loads, $76. As this ore was taken out while sinking one of the shafts, the result indicates improvement in depth. This property is to be opened soon, a procedure fully warranted by the results of other operations in this vicinity.

THE RODGERS MILL.

This, a ten-stamp custom mill, driven by water power, is situated on Wolf Creek, half a mile below the town of Grass Valley.

THE LARRIMER MILL,

Also on Wolf Creek, half a mile below the Rodgers, has ten stamps and is driven by water. Two concentrators save the sulphurets.

WORK YOUR OWN DIGGINGS.

A mine with the above name, on Ophir Hill, about one mile southeasterly from Grass Valley, is being worked by a company of young men, natives of the county. They have good hoisting works and a fine prospect for a good mine, in which some very good ore has lately been found. There is also a small mill on the property, but, for some reason not stated, the ore is being sent to a custom mill.

WASHINGTON DISTRICT.

YUBA MINE.

This property is situated on the South Yuba River, three miles above the town of Washington, at an altitude of three thousand one hundred and ten feet. The claim, which is patented, is three thousand feet on the lode line by six hundred feet in width. The course of the vein is about northeast and southwest; dips easterly 50 degrees; average width, six feet. The mine is opened by a tunnel one thousand one hundred feet long, eight hundred feet being in the vein. At a distance of five hundred feet from the tunnel mouth an inclined shaft has been put down six hundred feet in the vein.

The vertical depth from surface reached in the tunnel is not given, but must be considerable, as the ground rises at a high angle. The formation of the hanging-wall is greenstone, with slate casing; the foot-wall has a talcose slate casing eight inches thick, and then "granite." Six thousand gallons of water come into the mine every twenty-four hours. The water is raised by one Cope & Maxwell and one Duplex steam pump, both worked by air from a Burleigh compressor, which also operates the National and Ingersoll drills. Hercules and Vulcan powder are employed to the extent of one ton per month. But little timbering is required. The cost of mining is $2 20 per ton of ore.

The ore here is white quartz of the peculiar crystalline, fragile kind, common in the district; much of it can be easily broken by the fingers; it contains free gold, a small proportion of the peculiar brownish pyrites (pyrhotite) of the district, and zinc blende, which being black is mistaken by some for galena. The ore is treated by wet crushing and amalgamation. The mill has fifteen stamps, ten of which are now idle; the stamps weigh nine hundred pounds each, drop seven inches eighty-six times per minute, and crush two tons of ore in twenty-four hours to the stamp, through screens of No. 40 brass wire gauze, with a discharge surface of forty-six inches in length by seven in height placed vertically. The average duration of a screen is one month. A set of shoes and dies lasts sixty days. The consumption of iron per ton of ore crushed is two and seventy-seven hundredths pounds, and the cost $0 13.85, at 5 cents per pound for

chilled cast-iron delivered. The aprons, which are silvered, are four feet by five feet, and have an inclination of one and three fourths inches to the foot. The plated sluices are fourteen inches wide (clear of cleats), and each battery has a total of forty-eight feet in two lines, each twenty-four feet in length, all silvered. In the mills about here it has been found impossible to work with unsilvered plates, the quicksilver soon disappearing from plain copper. The mortars are provided with inside front plates forty-eight inches in length by five inches wide. The mill has no rock breaker, but is furnished with Hendy feeders. Of the gold recovered 90 per cent is found in the mortars and 10 per cent on the outside plates. The amalgam retorts 40 per cent, worth $17 per ounce before being melted. The ore has paid an average of $8 per ton during the past year. The loss of quicksilver has been at the rate of ten pounds to nine hundred tons, or .011+ of a pound, or .177+ of an ounce per ton of ore. The tailings assay on an average 40 cents per ton. There are no concentrators in the mill, as the sulphurets are scarcely rich enough to justify the expense of saving, being too poor to ship and not sufficient in quantity to be worked on the spot.

The mine gives employment to fourteen men, and the mill to three; wages $3 per day. Developments in addition to the tunnel and shaft amount to three thousand feet of levels about half worked out. The power of the mill is derived from a seven-foot Pelton wheel under sixty-six feet of pressure; that for the air compressor from a six-foot Pelton wheel, under one hundred and forty feet of pressure. The water is owned by the company. It is proposed to put in a new and larger compressor soon.

The vein can be traced for about four miles to the northwest across the South Yuba, being visible for some four thousand five hundred feet on the tunnel side of the river.

Altitude	3,110 feet.
Length of ore shoot	700 feet.
Length of shaft on incline	600 feet.
Length of tunnel	1,100 feet.
Water raised in twenty-four hours	6,000 gallons.
Hanging-wall	Greenstone, slate casing.
Foot-wall	Granite, slate casing.
Kind of powder used	Hercules and Vulcan.
Quantity of powder consumed per month	1 ton.
Cost of mining	$2 20 per ton of ore.
Character of works	Wet stamp mill.
Number of stamps running	15
Weight of stamps	900 pounds each.
Drop of stamps	7 inches.
Drops	86 per minute.
Duty of stamp	2 tons in twenty-four hours.
Kind of shoes and dies	Chilled iron.
Cost of shoes and dies	$0 05 per pound.*
Cost of shoes and dies per ton of ore crushed	$0 1385
Consumption of quicksilver per ton of ore	0.177 ounces.
Cost of milling	$0 80 per ton.
Yield of ore	$8 per ton.
Value of gold	$17 per ounce.
Assay of tailings	$0 40 per ton.
Kind of screen	No. 40 brass wire.
Dimensions of apron (silvered)	5 feet wide, 4 feet long.
Width of plated sluice	14 inches.
Length of plated sluice to each battery	48 feet.
Kind of feeder	Hendy Challenge.
Percentage of recovery saved in battery	90
Percentage of recovery saved on plates	10
Number of men in mill	3
Number of men in mine	14
Wages in mill	$3 per day.
Wages in mine	$3 per day.

*This is less than at the other mills in the vicinity. Probably there is a slight inaccuracy here.

BLUE BELL MINE.

This property, which is located on the South Yuba River, three miles east of the village of Ormonde, covers an area one thousand five hundred feet long by one thousand two hundred feet wide, the claim being a double one. The country on the east is granitic, on the west protogine, locally called granite also. The rock in contact with the middle vein, on which the main shaft is sunk, is, however, on the east a black slate, and on the west or foot-wall a talcose slate; the veins being thus in a belt of slate lying between the granite and protogine.

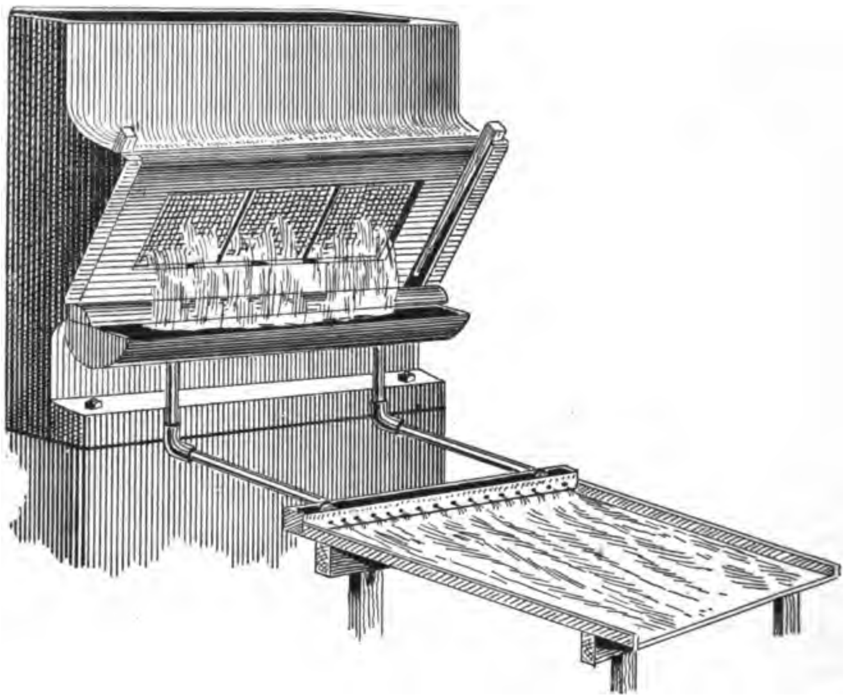
The claim includes three veins, which converge toward the vicinity of the main shaft. At a depth of about one hundred and seventy-five feet in the shaft the east vein comes into the middle vein, the west vein being expected to join it at a point a little further north.

The developments consist of an inclined shaft sixteen feet by six feet, and two hundred and six feet deep on the dip, which is 80 degrees toward the east, the course of the middle vein being nearly north and south; a first level two hundred feet long, and a second level one hundred and forty feet long. The ore has been stoped out between the levels for a length of thirty feet north of the shaft, the ore in the breast being six feet wide on an average. On the south of the shaft no stoping has yet been done. The vein shows a width of from two to fourteen feet at the point where the east vein comes in. At this point is a cross course of slate, similar to that forming the walls or casing of the vein. This cross course extends from wall to wall, with a thickness of about two feet, nearly at right angles with the strike of the vein, and pitching northerly and downward at an angle of about 45 degrees. Although the vein is cut entirely across by this wall of slate, the ore on each side of it is of the same quality and appearance, nor is the vein faulted in the least. The lower extremity of the cross course has not yet been reached.

The mine is effectually ventilated by means of a simple device in the nature of a water blast. This consists of a wooden pipe, about a foot square and sixteen feet long, connected at one end with a wooden box, or air chamber, from which an iron pipe leads down the shaft. A stream of water, under a two hundred-foot pressure, issues in the form of a number of fine jets from a sprinkler attached to the water pipe. These jets are directed into the open end of the square wooden pipe, which they enter to the distance of a few feet, when the water flows back and out of the pipe by gravity, while the air carried in by the jets passes down the pipe into the shaft. To facilitate the outflow of the water, after it has done its work, the apparatus is fixed in a slightly inclined position. This mine is quite new, and all the work, including the erection of mill and hoisting works, has been done since April 1, 1887. It is intended to add twenty to the present number of stamps.

The average yield of the ore, it is stated, has been $9 per ton in free gold, and about 2 per cent of sulphurets, having a value of from $160 to $250 per ton, which have not been separated yet, the tailings being impounded for future treatment.

Mr. Tregidgo, the Superintendent, has invented an improvement, on which he has applied for a patent, and which is designed to facilitate the operation of changing and repairing screens, renewing shoes and dies, cleaning out the mortar and such other work as requires free access to the front of the battery, usually obstructed by the apron, as shown in the following sketch:



The device consists of a semi-cylindrical iron trough, the length equal to the width of the mortar, and having a breadth of one foot, and a depth of six inches. This trough is fixed under the lip of the mortar, in the place usually occupied by the apron; in the bottom of the trough are two openings two inches in diameter, in which are fixed two pieces of two-inch iron pipe, each about eighteen inches long, extending vertically downward. The lower ends of these pipes are connected by elbows with horizontal pipes of equal diameter, and about three feet long. The trough receives the pulp from the mortar, the pipes into which the pulp flows delivers it to a distributing box from which it passes, through holes bored in the front, on to the apron. By this contrivance the apron is removed some distance from the battery, in front of which the workman can pass without having to climb over the apron or sluice. When it becomes necessary to clean the mortar, the upper ends of the pipes are plugged, the trough forming a convenient receptacle for the rock, sand, etc., taken from the mortar. The sides of this trough are lined with curved plates of silvered and amalgamated copper, not fixed close to the side of the trough, but with a space of about three quarters of an inch left between. The pulp from the mortar swashes from side to side in the trough in front of the copper plates, and a considerable portion of the gold is retained on the plates, which are secured to the trough by bolts with rubber washers placed between them, thereby preventing their contact. Mr. Tregidgo also uses a lip-plate on the mortar, outside of the screen. The inside back plates are five inches long by twelve inches wide; the front plates are attached to chuck-blocks as usual, the foot-rail of the screen frame being about five inches high, in order to afford the necessary space. The faces of the "chuck-blocks,"

and consequently of the plates, are rounded instead of being flat, the rounded form being better adapted for saving the gold. The aprons here in use are five feet by four feet, with an inclination of one and three quarters inches to the foot; at their lower end is a drop of about a foot, to the sluices; the pulp, however, does not drop, but flows downward on a curved plate which catches a good share of amalgam.

There are two plated sluices twenty feet long and sixteen inches wide, placed side by side, to each apron, that is, to each battery of five stamps. About 80 per cent of the recovery is in the battery, the rest on the various outside plates. The plates are all silvered. There is no rock breaker in the mill, but it is furnished with Hendy feeders. The shoes and dies in the batteries are of chilled iron, costing 5½ cents per pound, delivered. A set of shoes and dies lasts from forty-five to fifty days, crushing from sixteen to eighteen tons of ore per day with ten stamps. The cost of shoes and dies per ton of ore crushed is 13¾ cents. The stamps weigh eight hundred and fifty pounds each when newly shod; drop from five and one half to six inches, and crush from one and six tenths to one and eight tenths tons of ore per stamp in twenty-four hours, through No. 30 brass wire screens, with a discharging surface to five stamps of forty-eight inches in length by five inches in height. The screens stand vertically. The cost of milling is stated to be 80 cents per ton; just double the cost in the Washington Mill, under the same superintendence. The difference is due to several causes. This mill is some four miles further up the river than the Washington Mill and has to be reached over a very rough road. This mill has but ten stamps against twenty in the other, and no rock breaker, and the quartz is more compact, and, therefore, hard to crush, as shown by the difference in the stamp duty of the two mills.

This company employs from twenty to thirty men in the mine and tw in the mill; wages, $3 per day. The mill is driven by a Pelton wheel six feet in diameter, making one hundred and ninety-two revolutions per minute, under two hundred and forty feet pressure. For hoisting and pumping at the mine there is a Pelton wheel of nine feet diameter under two hundred and ten feet pressure. About thirty miner's inches of water are used in the mill for all purposes.

The company has a water right with almost unlimited power, the water falling down a cliff about one thousand feet before being taken up for use.

Altitude	3,200 feet.
Length of shaft on incline of 80 degrees	206 feet.
Quantity of water raised in twenty-four hours	5,000 gallons.
Character of hanging-wall	Granite, with slate casing.
Character of foot-wall	Granite, with talcose slate-casing.
Kind of powder used	Giant, No. 2.
Quantity of powder used	750 to 1,000 pounds per month.
Cost of mining	$2 per ton.
Cost per foot of shaft	$30
Number of feet timbered	206
Kind of timber used	Spruce and pine.
Cost of timber	7 cents per running foot.
Character of ore	Quartz, free gold, pyrites, galena.
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamp	5½ to 6 inches.
Drops of stamp per minute	88 to 92.
Duty of stamp in twenty-four hours	1.6 to 1.8 tons.
Kind of shoes and dies	Chilled iron.
Cost of shoes and dies	5½ cents per pound.
Cost of shoes and dies per ton of ore crushed	13¾ cents.
Kind of screens	Brass wire, No. 30.
Dimensions of apron	5 by 4 feet.
Width of plated sluice	16 inches.
Length of plated sluice to each battery	40 feet.

Kind of feeder	Hendy's Challenge.
Kind of breaker	None.
Percentage of recovery saved in battery	80
Percentage of recovery saved on plates	20
Percentage of sulphurets, about	2
Value per ton of sulphurets	$160 to $250
Cost of milling, per ton	80 cents.
Number of men in mill	2
Number of men in mine	20 to 30
Average wages in mill	$3 per day.
Average wages in mine	$3 per day.
Quantity of water used in mill	30 miner's inches.

GRAFTON MINE.

In granitoid formation, parallel to the Eagle Bird. Vein, five feet wide. Tunnel on vein, two hundred and fifty feet; pay shoot, eighty feet long.

EAGLE BIRD.

Work on this mine, which is situated on the bank of the Yuba River, opposite the Blue Bell, was suspended over a year ago, but for what reason we have not been able to learn. Preparations are being made to resume work.

WASHINGTON MINE.

This mine, located many years ago as the Becker, is situated close to the village of Ormonde, near the junction of the South Yuba River and Cañon Creek, at an altitude of two thousand eight hundred and fifty feet.

The course of the vein, which seems to be a true fissure, is 15 degrees east of north and west of south, the dip being 89 degrees westerly. The first pay shoot has a length of three hundred and forty feet and an average width of three feet. The second is seventy-three feet long and from seven to sixteen feet wide. The latter has been stripped to a length of one thousand two hundred feet, and can be traced for a distance of three miles. The casings and black talcose slate contain plumbago, which interferes with amalgamation. The ore is quartz, free gold, pyrites, and blende, yielding from $6 to $8 per ton in free gold and about 2 per cent of sulphurets, worth from $80 to $100 per ton. The latter are saved on blanket sluices and reserved for further disposition. This mine is worked through a tunnel run seven hundred and sixty-five feet in the vein, reaching a vertical depth from the surface of one hundred and eighty feet, and by a main shaft from the tunnel, a further depth of one hundred and sixty feet is reached in the mine. The quantity of water coming in—four hundred cubic feet in twenty-four hours—is raised by a Cornish lift pump. The tunnel, which is five feet wide by six and a half feet high, cost $6 10 per foot. The shaft, which is twelve feet by eight feet, cost $34 per foot, one foot per day being sunk by nine men. Both tunnel and shaft are timbered with pine and spruce, costing 4 cents per running foot; the timber being cut on the company's ground. The powder used is Giant, No. 2, of which from five hundred to one thousand pounds are consumed monthly. The mine employs from twenty-five to thirty men at $3 per day.

The company has built a dam on the South Yuba, and three fourths of a mile of ditch and flume, which supplies water for an overshot wheel of forty-two feet diameter and six feet breast. Four hundred inches of water are delivered on this wheel, under a head of one hundred and eighty feet, giving about fifty-horse power, which drives the mill. A nine-foot Pelton wheel, under a like pressure, is used for pumping and hoisting in the mine.

The developments, in addition to the main tunnel and shaft, are: Three upraises from tunnel to surface, drifts from the main shaft two hundred and forty feet southward and sixty-five feet northward, and a winze forty-two feet deep from the main tunnel, at a point four hundred and twenty-five feet from the main shaft. The company's wet stamp mill is on the mine, and contains a Blake's improved rock breaker, and twenty stamps of eight hundred and fifty pounds each, dropping from five and one half to six inches, from eighty-eight to ninety-two times per minute. Each stamp crushes two and two tenths tons of ore in twenty-four hours, through a thirty-mesh brass wire screen, having a discharge surface of forty-eight inches in length by five inches high. The thirty-mesh screen is to be replaced by one of forty meshes to the linear inch. The screens are placed at a slight inclination from the perpendicular. The amalgam plates, apron, and sluices are similar to those in the Blue Bell Mill, both being under the same superintendency. The blanket sluices are soon to be replaced by machine concentrators. Of the amalgam, three fifths is obtained in the battery, one fifth on the trough plates (see notes on Blue Bell), and the remainder on the apron and sluice plates. The shoes and dies are of chilled iron, costing 5¼ cents per pound at the mill, an average of 12½ cents per ton of ore crushed, this being slightly less than in the Blue Bell and Yuba Mills. The loss of quicksilver, per ton of ore, is not given, but the total cost of milling is stated to be 40 cents per ton; that of mining, $2 per ton.

Altitude	2,850 feet.
Length of ore shoot	First, 342 feet; second, 73 feet.
Vertical depth reached in mine	340 feet.
Quantity of water raised in twenty-four hours	400 cubic feet.
Character of walls	Slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used	500 to 1,000 pounds per month.
Cost of mining	$2 per ton.
Cost of tunnel	$6 10 per foot.
Cost of shaft	$34 per foot.
Number of stamps	20
Weight of stamp	850 pounds.
Drop of stamp	5½ to 6 inches.
Drops of stamp	88 to 92 per minute.
Duty of stamp	2.2 tons in twenty-four hours.
Kind of shoes and dies	Chilled iron.
Cost of shoes and dies	5¼ cents per pound.
Cost of shoes and dies per ton of ore crushed	12½ cents.
Size and character of screens	Brass wire, No. 30.
Dimension of aprons	Length, 4 feet; width, 5 feet.
Width of plated sluices	16 inches.
Length of plated sluices	40 feet to each battery.
Number and kind of feeders	4 Hendy's.
Percentage of recovery saved in battery	60
Percentage of recovery saved on plates	40
Cost of milling	40 cents per ton.
Percentage of sulphurets	2
Value of sulphurets	$80 to $100 per ton.
Number of men in mill	4
Number of men in mine	25 to 30
Wages paid in mill and mine	$3 per day.
Water used for power in mill	400 miner's inches.
Water used for power in mine	Not given.
Fall of water used for power in mine	180 feet.

CHAMPION MINE.

At Maybert, on the South Yuba; course of vein, north and south; dip, east 70 degrees; length of tunnel on vein, two hundred and fifty feet; depth of winze, forty feet; the mill a Huntington, driven by water power. A lot

of ten tons of picked ore yielded $32 50 per ton; another lot of twenty tons paid $17 50 per ton; in all, some seventy to eighty tons of rock have been worked.

SPANISH MINE.

This mine, located in 1883, company incorporated in 1884, is situated three miles north of the town of Washington, at an altitude of four thousand feet. This property consists of ten claims, one thousand five hundred by six hundred feet each. The course of the vein is north and south; dip, 80 degrees to the west, averaging in thickness ninety feet. The hanging-wall is a soft slate, shaly, and not well defined. The foot-wall is a hard slate and well defined. The true vein, however, is on the foot-wall, and consists of solid quartz about four feet thick; it does not pay for working and is therefore left in place. The pay is found in the soft slate on the hanging-wall side, which contains many veinlets and streaks of ferruginous quartz, carrying gold. Where no quartz is to be found there is no pay. The slate on this, the west side, is talcose.

The main tunnel is in one thousand two hundred feet. There is also a lower tunnel now being driven by contract, at the rate of $3 per foot. The vertical depth from the surface at the end of the main tunnel is three hundred and fifty feet; the lower tunnel being two hundred and thirty feet below the main one. There are seven upraises from tunnel to surface, and ten crosscuts in the vein. In stoping it is sometimes necessary to timber with square sets more especially during the winter season, otherwise no timbers are required. About fifteen inches of water flows from the tunnel. The cost of mining is 25 cents per ton of ore. One of the methods employed here in ore extracting is as follows: There is an excavation from the tunnel to the surface, which has acquired the form of an open cut, with sloping sides (these sides being too steep for a man to stand on); a Chinaman, armed with a churn drill, is lowered to a sufficient distance by means of a rope. When the drilled hole is deep enough, it is charged with about five pounds of powder and fired, causing a large quantity of the soft slate to slide to the bottom, whence it is taken out through the tunnel. The powder used is No. 2 Vulcan, containing 35 per cent nitro glycerine, the daily consumption being twenty-five pounds.

The mine employs, besides a foreman, two white men and eight Chinamen, who extract about four thousand tons of ore per month, enough to keep the mill steadily occupied. This ore yields an average value of 70 cents per ton. The cars are drawn into the mine by mules, coming out by gravity. The wages paid here are: white men $3 per day, foreman $3 50, and Chinese $1 50 per day. The ore is passed through a Blake rock breaker, and then ground in Huntington roller mills, of which there are three of five feet diameter, and one of four feet. These mills, which make fifty-eight revolutions per minute, are fed by Hendy feeders, operated by a small shaft carrying eccentrics, the extent of the throw for each being regulated by means of levers and racks. The frequent necessity for readjustment of the feed is the greatest difficulty in working these mills, since no way has yet been found of making them regulate the feed automatically, according to the requirements, as the stamp battery does, the rate varying according to the proportion of the quartz in the ore.

After being started, quicksilver is put into these mills at the rate of about one quarter ounce to each ton of ore. The aprons are multiple, sheet over sheet, with spaces of about one inch between. They are four feet wide; the lower one and the one immediately above it are each four feet long; the third is three feet long, and the fourth two feet long. The

lower ends being placed even, one with another, the plates from the second upward are in step form at the upper ends. Over the steps is a sheet of perforated iron, which receives the pulp from the mill, and, the perforations being suitably arranged, distribute the pulp, in approximate proportion, among the four plates, of which (except the lower one, which is in contact with the wooden support) both upper and under surfaces take part in retaining the particles of gold and amalgam escaping from the mill.

Each mill has two such aprons. This arrangement was contrived by Mr. Bradley, on account of the large quantity of ore passing through the mills, about thirty-five tons each in twenty-four hours. Nothing is found on the second set of aprons unless the ore pays over 75 cents per ton. Below the two sets of compound aprons described, there are "tailplates," four feet wide by six feet long. These sometimes yield more amalgam than the second set of apron plates, due, as Mr. Bradley supposes, to the circumstance that the pulp in passing from the aprons to the tailplates has to flow over two falls and through the holes in a perforated trough, which causes the particles to mix and change position. The aprons have an inclination of two inches to the foot. The tailplates have one inch to the foot in a part of the length, changing to almost a level near the lower extremity. It is a significant fact that what amalgam is collected on the tailplates is chiefly found at that point at which the inclination changes; that is, in the curve. Each mill has three screens, slot punched, No. 5, with a clear discharge surface of thirty inches in length by eight inches high.

The cost of the shoes and dies for the mill is 10 cents per pound at the mill, and the consumption is at the rate of 4.1 cents per ton of ore worked. The cost of the screens is 1.2 cents for each ton of ore; this is considered large in proportion to other expenses, and experiments are to be made with screens manufactured from saw plate. The total cost of milling is 25 cents per ton. Of the amalgam recovered, 60 per cent is obtained from the mills, and 40 from the plates. The gold recovered in the mills is of coarse grain, and the amalgam from this source retorts about 40 per cent. The gold from the plates is very fine, the amalgam yielding only 20 per cent of its weight in gold on retorting. The value of the gold averages $15 50 per ounce. An excess of quicksilver is kept in the mills; that is, more than would suffice to make solid amalgam. At times, especially when a rather large piece of rock gets in, the mill will throw the quicksilver out on the apron. The loss of quicksilver is one thirtieth of an ounce per ton of ore.

On the whole these mills are here doing very good work. Contrary to a common impression, clay in the ore does not cause trouble, for this ore contains a large proportion of clay matter; it also contains a considerable, though not large, proportion of hard quartz. The mills here, and their appendages, are driven by a Pelton wheel with forty inches of water* under three hundred and ten feet pressure. Water costs 15 cents per inch, or $6 per day. The ore carries a trifling proportion of pyrites, containing gold to the value of $60 per ton. For a time one ton was saved per month, by means of blankets, but it was not considered profitable. The reduction works give occupation to a foreman, three white boys, and three Chinese. The foreman earns $3 50 per day, the boys $2, and the Chinese $1 50 per day each.

Altitude	4,000 feet.
Length of main tunnel	1,200 feet.
Length of lower tunnel	230 feet.

*Bloomfield measure, a two-inch slit where the water is six inches above the top of the slit, or seven inches above the center.

Upraises to the surface	7
Crosscuts	10
Vertical depth from surface	350 feet.
Walls	Hanging, soft slate; foot, hard slate.
Powder used	No. 2 Vulcan, 25 pounds per day.
Cost of new tunnel	$3 per foot.
Cost of mining	$0 25 per ton.
Cost of milling	$0 25 per ton.
Number of men in mine	10
Number of hands in mill	6
Wages in mine	Whites, $3 per day; Chinese, $1 50 per day.
Wages in mill	Boys, $2 per day; Chinese, $1 50 per day.
Crushing machines	4 Huntington mills.
Kind of screens	Slot. No. 5.
Cost of shoes and dies	10 cents per pound; $4\frac{1}{10}$ cents per ton of ore crushed.
Loss of quicksilver	One thirtieth of an ounce per ton of ore crushed.
Water for power	40 miner's inches.
Pressure of water	310 feet.
Cost of water	15 cents per inch.

During the month of August the quantity of ore crushed was four thousand one hundred and twenty-six tons, which yielded, in gold, $2,128 33; silver, $24 96; total, $2,153 29, or about 52 cents per ton, being, as stated by the Superintendent, less than ever before, while, for some unknown reason, the loss of quicksilver was greater than usual.

The gold value recovered was 51½ cents per ton. The tailings were thoroughly sampled during the run; and the sample sent to the Bureau, being carefully assayed, was found to contain an average of 70 cents per ton in gold; hence the working result was 42.4 per cent of the original gold contents of the ore, namely, $1 21½ per ton.

On carefully grinding and washing a little of the tailings in the agate mortar, a few bright specks of gold were visible by the aid of a lens, but not a particle of quicksilver could be seen; there were also a very few particles of pyrite. About half of the material was too coarse to pass a thirty-mesh sieve.

COLUMBIA HILL DISTRICT.

DELHI MINE.

This mine is situated in a deep ravine putting into the Middle Yuba from the south at a point three and a half miles in a westerly direction from the town of Columbia Hill, its altitude being two thousand five hundred feet. This property was noticed in the report of the State Mineralogist for 1886. As it has been, however, undergoing considerable changes since, a further description of it seems required at this time. The country in the vicinity of this mine is metamorphic slate, intersected by dikes of crystalline rock; the topography being such that the mine can be worked to a great depth by tunnels. The course of the vein is about north 10 degrees east by south 10 degrees west, with an easterly dip of 75 degrees and an average width of six feet.

The length of the ore shoot is stated at three hundred and fifty to four hundred feet, though on inspection it seemed to be somewhat less. The mine is opened by two tunnels, and a third tunnel of four hundred and seven feet in length is on the point of cutting the vein at the depth of five hundred and twenty-five feet. Above Tunnel No. 1 the ore shoot is worked out. In No. 2 stoping is going on. The walls are slate, with a slight black gouge. They are very smooth and perfect in general. About two hundred inches of water is flowing from Tunnel No. 2; and in No. 3, near the vein, it falls in torrents from the roof, since cutting through one of the dikes mentioned, which seems to accompany the vein at no great distance

in the hanging-wall. Giant powder, No. 2, is used for blasting, and of this about five tons are consumed a year. The drilling is by hand. The average cost of mining and milling for the year has been $2 per ton. No. 3 tunnel cost $10 per foot, without the track, being driven at the rate of fifty feet per month, by the labor of six men. The dimensions of this tunnel are six feet by seven feet. The tunnels do not require timbering. The stopes are heavily timbered with spruce and pine, costing 1½ cents per running foot in the woods; 2½ cents at the mine.

The company has constructed four miles of road for wood and lumber hauling, and six miles of ditch for bringing in water. The mill being on the mine, there is no expense for transportation of ore. The ore is quartz, carrying iron and copper pyrites, arsenical pyrites and a small proportion of galena and blende. It is treated by wet stamping, amalgamation in the batteries and on plates, and concentration by Frue and Triumph vanners. The mill is worked by water power with two hundred and forty feet fall, by means of four Pelton wheels, as follows: One on a Blake rock breaker, using ten inches; one on stamps, thirty-six miner's inches; one on hoist, fifteen miner's inches; one on concentrator, fourteen miner's inches. The total water used for power is seventy-five miner's inches. The water is owned by the company.

The ore here has to be hoisted, for the reason that the mill is located above Tunnel No. 2, through which the ore is now brought out. The mill has eighteen stamps, in two batteries of four each, and two of five each. The weight of each stamp in the four-stamp mortars is one thousand pounds; in the five-stamp mortars, one thousand one hundred pounds. The drop is six inches, and the number of drops per minute ninety-four. Each stamp crushes two and one half tons in twenty-four hours, and can, if required, crush three and one half tons daily, through a No. 10 short slot-punched screen.

The screens are vertical in the four-stamp mortars, and inclined in those of five stamps. No difference has been observed in results from this arrangement, though owing to the greater weight of the stamps in the five-stamp batteries, and, probably also because five stamps can be worked in a more advantageous manner than four, the five-stamp batteries crush considerably the greater quantity of ore per stamp. The shoes and dies are of cast-iron from Nevada City, and cost 6 cents per pound at the mill. A set of shoes and dies will last sixty days, which, it will be observed, is longer by nearly 50 per cent than is usual. But in order to save freight on waste iron they are made heavier than usual for this mill, the faces being, respectively, nine inches and ten inches in diameter. The tappets are fourteen and sixteen inches. Both cams and tappets are of cast-iron. When the ore is poor the batteries are run faster, crushing up to three and one half tons per stamp per day; with good ore, less. Hence it may be inferred, as they are now only crushing two and one half tons per stamp per day, that the ore at present coming from the mine is fair quality at least.

The unusually high stamp duty in this mill must be ascribed mainly to the comparative coarseness of the screens, but partly also to the use of a rock breaker and of machine feeders. The screens on the four-stamp batteries are forty-four inches long by fourteen inches high inside the frames; on the five-stamp batteries they are fifty-five inches long and twenty inches high. Of the amalgam obtained 35 per cent is recovered from the mortars, the remainder from the various plates. The reason of the comparatively small proportion saved in the batteries is chiefly the coarseness of the screens in some degree, this result being due also to the fine condition of the gold. The aprons are in four sections, each four feet long and as wide

as the respective mortars, there being from section to section a drop of a few inches. From these plates the pulp passes to the concentrators—two Triumph and two Frue—after which it flows over four plates, each twelve feet long by eighteen inches wide, arranged in sections like the upper plates, in step form, with a trough across the lower end. Back plates have been used in the five-stamp batteries, but will be replaced by riffles. Chuck blocks (front plates) from four to five inches high, and the length of the mortar, are only used with very rich ore, speed being then reduced to eighty drops per minute. The plates are all silvered.

The ore here yields about 3 per cent of sulphurets, of the assay value of $80 to $100 in gold per ton. The concentrates are treated by chlorination, at the company's works, adjacent to the mill, at a stated cost of $6 per ton, 93 per cent of the assay value being recovered. From the tunnel the ore is hoisted, by water power, on a tramway laid on the steep hillside to a sufficient height above the mill, where it is dumped on the grizzlies. The very coarse part is then passed through the breaker, when it falls into the bin below, along with that which passed through the grizzlies. From the bin the ore passes, by gravitation, through chutes to the feeders. This is the arrangement of all first class gold quartz mills. The best results, in general, are obtained here by giving the stamp six-inch drops, and ninety-four drops per minute.

The walls are slate, exceptionally good, especially the foot. The stated average width of the vein is not in the least exaggerated, and everything, from wall to wall, within the limits of the shoot, goes to the mill. If Tunnel No. 3, which will be in long before this report appears, should expose as good a vein as did No. 2, the prosperity of the enterprise will be assured for a long time. The vein in the shoot is remarkably solid. Nearly all is quartz, which can be taken out in great masses several feet long across the vein. The acting Superintendent states that he is in the habit of making frequent assays of the tailings, with results which indicate very satisfactory work, being 75 cents to $1 per ton. Judging from these results the gold can hardly be as fine as seems to be implied in another part of these notes. Otherwise, the tailings would probably be richer, for want of sufficient comminution of the rock, owing to the coarseness of the screens; which, therefore (and not the fineness of the gold), is responsible for the large proportion of amalgam obtained from the plates. (Mechanical, not chemical, fineness of the gold is meant.) The yield of the ore per ton is not given; but from various indications it would seem to be not less, and probably more, than $12 per ton.

In the mine ten men are employed in stoping for the eighteen stamps. The mill employs five men, and five more are variously occupied about the works. The wages paid in mill and mine are $3 per day; for outside work, $2 50 per day.

The chlorination works are not in operation just now, being required only at intervals as the concentrates accumulate. The plant presents nothing new in its arrangements. It consists of a reverberatory furnace, sixty by twelve feet outside measure, in three hearths and with a capacity for roasting four tons of concentrates daily; three gassing tubs, capacity each three tons of roasted ore; three precipitating tubs, each seven feet diameter by thirty inches deep inside; two chlorine generators, and all other necessary tools and apparatus, including an assay office and melting room. The fuel used for roasting is spruce wood, costing $3 per cord, and the consumption is stated at fifteen cords per month, which would be at the rate of one hundred and twenty-five thousandths of a cord per ton of ore—an unusually small proportion. There is a second vein in the foot-wall which

does not pay for working, and the existence of a third is suspected on the hanging side.

Altitude of company's office	*2,500 feet.
Length of ore shoot	350 to 400 feet.
Length of new tunnel, No. 3	407 feet.
Vertical depth in new tunnel	525 feet.
Cost of new tunnel	$10 per foot.
Formation of walls	Slate.
Cost of mining and milling	$2 per ton.
Number of stamps	18
Weight of stamp	1,000 to 1,100 pounds.
Drop of stamp	6 inches.
Drops	94 per minute.
Duty of stamp	2.5 tons in twenty-four hours.
Kind of screens	Short slot, No. 10.
Kind and number of feeders	Hendy, 4
Kind and number of breakers	Blake, 10-inch, 1
Plates to each battery	Length, 16 feet; width, 45 feet.
Plated sluices, each	Length, 12 feet; width, 18 inches.
Kind of concentrators	Frue and Triumph.
Number of concentrators	8
Percentage of sulphurets	About 3
Value of sulphurets	$80 to $100 per ton.
Treatment of sulphurets	Chlorination.
Stated cost of treatment of sulphurets	$6 per ton.
Percentage of assay of sulphurets recovered from chlorination works	93
Capacity of furnace per twenty-four hours	4 tons.
Kind of fuel used for roasting	Spruce.
Cost of fuel	$3 per cord.
Consumption of fuel per ton of ore	0.13 cords.
Number of men in mine	10
Number of men in mill	5
Number of men outside	5
Wages paid in mine	$3 per day.
Wages paid in mill	$3 per day.
Wages paid outside	$2 50 per day.
Kind of power used	4 Pelton water wheels.
Water used for power, measured under 6-inch pressure	75 miner's inches.
Fall of water used for power	240 feet.
Kind of powder used in mine	Giant, No. 2.
Quantity of powder used per year	5 tons.
Drills used	Hand.
Kind of timber used in stopes	Spruce and pine.
Cost of timber, per running foot	2½ cents.
Kind of shoes and dies in mill	Cast-iron.
Cost of shoes and dies at mill	6 cents per pound.
Duration of set of shoes and dies in mill	60 days.

ENTERPRISE MINE.

This property, belonging to the Delhi Company, is eight hundred feet westerly from the Delhi. It is difficult to give much account of the mine at present, owing to the irregularity of the formation. It is opened by a tunnel, which runs northwest about three hundred feet, and then makes a turn and runs nearly southeast, cutting a stringer in the northwest portion and a large flat irregular deposit near the end. Nothing can be said as to the course of this deposit until that shall be revealed by further exploration. There seems, however, to be the promise of a good mine in this prospect, which meanwhile has the excellent quality of paying its way.

The El Dorado Mine, located near Columbia Hill, is being opened by Nevada City parties, with good results.

*Mr. E. H. Garthwaite gives two thousand seven hundred feet as the altitude; probably he refers to the croppings above the office on the hill.

EUREKA DISTRICT.

GASTON RIDGE MINE.

This mine, locally known as the California, is situated four miles south of Graniteville, at an altitude of five thousand feet. The claim is three thousand feet in length on the lode line, by six hundred feet in width. The vein has a north and south course, and an easterly dip of 45 degrees, with a width of from two to thirty feet, and has paid for a length of one thousand feet.

The formation is slate and granite. The mine has been worked through a tunnel, six hundred feet long, of which three hundred feet are in bedrock. The vertical depth from the surface reached in the tunnel is one hundred and forty-seven feet. A new tunnel, now in six hundred feet, is being driven to tap the vein one hundred feet deeper. It is expected that it will reach the vein in another one hundred feet. Another tunnel on the same level is also being run toward the vein. The formation cut in the north tunnel consists of alternate beds of slate and granite. In the lower tunnel it is similar, but slate preponderating. These tunnels enter on the west, or foot-wall side, and as the ground below descends at a steep angle to the south fork of Poorman's Creek, there is afforded unlimited room for dumps. From the north tunnel there is a tramway level extending southward to the chute by which the ore is sent down to the mill, one hundred and thirty feet lower. From the lower tunnel the rock will be conveyed on a tramway, laid on the bank of the North Bloomfield ditch, to the mill. Three hundred feet of the vein has been stoped upward fifty-four feet, to the old works, and no more ore can now be taken out until the new tunnels are in, unless by working under foot.

The former company worked both north and south of the present works, and, as it is not exactly known to what extent, the present company will open new ground to the northward, cutting the vein meantime at greater depth to the southward. The mill remains unemployed. The vein is near the line of contact of slate and granite; the slate being in the foot-wall side, underlying the vein.

Between the north and south ends of the present works the vein changes its course for a distance of three hundred feet. Although the vein pinches at each end of the present works, that is, at each bend, it is of good size at other points, both northward and southward. From the north end of the drift to the south end of the old works is three hundred feet; as the old company worked six hundred feet northward from that point, the new north tunnel has been located further northward. About three miner's inches of water flows from the present working tunnel and much more from the lower new one. Three kinds of powder are used in the mine, namely: Giant, Vulcan, and Safety Nitro, altogether about two hundred pounds per month.

The cost of mining is estimated by the foreman at $1 25 per ton, but no records were kept; however, a contract has been let, at $2 50 per ton, to extract the ore from below the tunnel level, where hand pumping must be resorted to. This has been chiefly for the purpose of keeping the mine hands employed pending the completion of the new tunnels. The north tunnel is costing $1 50 per foot; the lower, $4 50. In the former, the dimensions of which are six by four and one half feet, three shifts make eight feet per day; in the latter, which is of the same size, three feet per day is the rate of progress.

Though the crosscut tunnels do not require timbers, in the vein, all the works are timbered. The cost of timber, which is cut on the property, is 1½ cents per running foot for round, peeled fir, spruce, and pine, and 2 cents apiece for logs, not delivered. The ore is a glassy quartz, with only a small proportion of sulphurets. The best paying ore, which is on the hanging-wall, is sometimes six feet thick; adjoining it is a soft, yellowish slate from one to two inches thick, behind which occurs granite. The gold, mostly all fine-grained, though some of it is coarse, is worth from $16 to $17 per ounce.

The mill was operated almost continuously from August 12, 1887, to June 14, 1888, in which time about $45,000 were taken out. It is driven by a steam engine with twelve-inch cylinder and thirty-inch stroke. Fuel costs $1 50 per cord on the ground where cut, and is delivered by floating in the North Bloomfield Ditch at an additional cost of 75 cents. The consumption, when running the mill, is three cords per day. This mine has been employing thirty men until recently; at present it employs eight. The mill employs six men when working. The wages in both mill and mine are $3 per day.

The mill carries ten stamps of seven hundred and fifty pounds weight each. They drop, on an average, seven and three fourths inches at the rate of ninety drops per minute, and crush per stamp two and a half to three tons of ore in twenty-four hours. The shoes and dies are of cast-iron, from Nevada City, costing 4½ cents per pound at the foundry, or 5½ cents at the mine. A set of shoes and dies last forty-three days. The screens have been various—No. 6, round-punched, No. 5 and No. 6, slot-punched—the dimensions being eight inches high by fourteen inches long, three to each battery; that is to say, the discharge surface to each battery is forty-two inches long and eight inches high; the screen being put on the frame in three separate pieces instead of a single piece, which gives this advantage, that any piece may be removed when necessary without stripping and wasting the others. In one mortar the screen is inclined; in the other it is vertical. No difference in results has been observed from this arrangement.

In crushing with different screens, the following was observable: No. 5 slot gave a duty to the ten stamps of about five tons per twenty-four hours more than No. 6 round; and No. 6 slot gave about half that difference as compared with No. 6 round, and was found to be the most suitable for the ore. With No. 5 slot more than half of the recovery came from the apron, etc., outside the mortars, while with No. 6 slot six sevenths was in the battery. The practice in this mill is to continue crushing as long as the shoes and dies last, and then stop and clean up; put in new iron and run again as long as that lasts, and so on. In this way time is saved—a clean-up coming about once in forty-three days. This will not, however, meet with the approval of all.

Some mill men think it is better to make a partial clean-up every two or three days. It would be interesting and instructive if this mill would run one battery on one system, and one on the other, for a time, keeping the amalgam separate, and finally ascertaining which gave the best result; not in weight of amalgam, which might be deceptive, but in actual value. No plates are used in the battery. The aprons are four feet square, with silvered plates, and an inclination of one and one fourth inches to the foot. The plated sluices are three feet wide, with a total length to each battery of twelve feet, with three drops and intervening troughs. The mill is not furnished with machine feeders. The tailings, which are concentrated on

blankets, yield an unknown, but small, percentage of sulphurets, which are treated by amalgamation in a pan and without chemicals.

Altitude at present working tunnel	5,020 feet.
Length of ore shoot	Not definitely known.
Length of first tunnel	600 feet.
Length of second tunnel	600 feet.
Vertical depth reached from surface	147 feet.
Kind of powder	Giant, Vulcan, Safety Nitro.
Quantity of powder consumed per month	200 pounds.
Cost of mining ore (contract)	$2 50 per ton.
Cost of new tunnel north	$1 50 per foot.
Cost of new lower tunnel	$4 50 per foot.
Number of stamps	10
Weight of stamp	750 pounds.
Drop of stamp	7.75 inches.
Drops of stamp	90 per minute.
Duty of stamp	2.5 to 3 tons in twenty-four hours.
Kind of shoes and dies	Cast-iron.
Cost of shoes and dies	5½ cents per pound.
Wear of shoes and dies	Set to 1,100 tons.
Kind of screen	Slot punched, No. 6.
Dimensions of aprons	4 feet long, 4 feet wide.
Width of sluice	3 feet.
Length of sluice to each battery	12 feet.
Kind of concentrators	Blankets, 32 feet.
Character of ore	Glassy quartz.
Proportion of recovery saved in batteries	Six sevenths.
Proportion of recovery on plates	One seventh.
Treatment of sulphurets	Amalgamation.
Power used in mill	Steam.
Fuel used in mill	Wood.
Cost of fuel	$2 25 per cord.
Consumption of fuel	3 cords per day.
Number of men in mill	6
Number of men in mine	30
Wages	$3 per day.

ROCKY GLEN MINE.

This property is located one and one half miles south of the town of Graniteville, at an altitude of five thousand feet. There are four veins in the claim, which covers fifteen hundred feet on the lode line of two of them, and something less on the other. The course of the veins is nearly north and south. The ore shoot in the back vein, which is now being worked, is three hundred feet long.

All of these veins were worked out long ago, above the level of the working tunnel, and are said to have paid well. The present workings consist of the old tunnel, thirteen hundred feet in length; an inclined shaft sunk to a depth of three hundred feet below the tunnel, and a level two hundred feet long driven at a depth of two hundred feet below the tunnel, giving a depth on the easterly dip of 70 degrees of about five hundred and fifty feet. The average width of this vein is three feet. The walls are granite, with a slate casing on the hanging-wall. The mine makes fifty gallons of water per minute, which is raised to the tunnel by a jackhead pump mainly, worked by compressed air, which, however, gives trouble by freezing. The Rix & Frith and the National drill are in use here. About half a ton of Safety Nitro powder is the estimated monthly consumption. The cost of mining the ore per ton cannot yet be given. The entire works have to be timbered. The ore is a glassy crystalline quartz, carrying lead phosphate (pyromorphite), and galena. It is worked by wet crushing and amalgamation, in the company's mill, located at the tunnel mouth. Ten stamps, of eight hundred pounds weight each, falling six and one half inches, at the rate of ninety drops per minute, crush twenty-three tons of rock every

twenty-four hours. The shoes and dies are of cast-iron, costing 4½ cents per pound at Nevada City. A set lasts forty days. The screens are No. 1, round punched, of common tinplate, and are said to work well. No aprons are used. Instead there are to each battery two silver-plated sluices, thirty feet long and fourteen inches wide in the clear. The feeding of the stamps is by hand, as is also the rock breaking. Two thirds of the gold recovered is found in the mortars; one third on the plates. There are no concentrators, and the sulphurets go to waste. A sample of these, obtained by pan washing, gave by assay $80 per ton. The mine employs forty men, and the mill two, at $3 per day each. The power for mill, compressor, pumping, and hoisting is derived from a number of Pelton and Donnelly wheels, using, in all, about one hundred miner's inches of water (Bloomfield measure, or seven inches pressure from top of aperture). This property is really in the condition of a prospect. The present company has been in possession only a year and a half, during which time it has retimbered the entire tunnel, sunk three hundred feet on the back vein, and cut a station on the second ledge (the Illinois). The mill, up to July, 1888, had been in operation about two months.

Altitude	5,000 feet.
Length of ore shoot	300 feet.
Depth reached on incline of 70 degrees	550 feet.
Quantity of water raised in twenty-four hours	72,000 gallons.
Character of wall rock	Granite.
Kind of powder used	Safety Nitro.
Quantity of powder consumed	1,000 pounds per month.
Cost of mining (per ton)	Not given.
Number of stamps	10
Weight of stamps	800 pounds.
Drop of stamp	6½ inches.
Drops of stamp	90 per minute.
Duty of stamp	2.3 tons in twenty-four hours.
Kind of shoes and dies	Iron.
Screens	Round punched, No. 1, made of tin plate.
Width of plated sluices	14 inches.
Length of plated sluices	Sixty feet to each battery.
Kind of pan (for clean-up)	Knox.
Percentage of recovery saved in battery	67
Percentage of recovery saved on plates	33
Cost of milling (per ton)	Not given.
Number of men in mill	2
Number of men in mine	40
Average wages	$3 per day.
Water used for power	100 Bloomfield inches.

GAMBRINUS MINE.

This mine, situated four miles south of Eureka, at an altitude of five thousand and seventy feet, is an old location, having been worked more than twenty years ago. It is now being reopened, a shaft being put down in the old tunnel. The country rock is granitic, with the slate belt lying not far to the east.

BALTIC MINE.

This mine lies about four miles east of Eureka. It belongs to the owners of the Gambrinus, who are running a tunnel to the vein.

WILLOW VALLEY DISTRICT.

ST. LUIS MINE.

This mine is located two and one half miles east of Nevada City. The owners, who are all working miners, have chiefly with their own labor

recently completed a tunnel one thousand four hundred feet long, which intersects the vein at a depth of two hundred and twenty-five feet. From the owners on the ground was derived the following information in regard to this property:

The old works consist of an inclined shaft two hundred feet long, and a drift one hundred and sixty-six feet long, showing a good vein for a length of one hundred and twenty-five feet. Three tons of ore from the lower (old) works were sold on the dump three years ago to O. Maltman, of Nevada City, for $243 per ton. Another lot of two tons, shipped to Selby & Co. the past summer, brought $223 per ton. Three tons worked in the Deadwood Mill paid $115 per ton. Some sixty to seventy tons of rock, stoped out about three years ago, yielded by mill process from $30 to $40 per ton. The gold is worth about $16 60 per ounce.

The owners, four in number, have been three years driving the new tunnel—a large undertaking by poor men—but such was the confidence felt by merchants of Nevada City, in the merit of the mine, as well as in the pluck and perseverance of the company, that credit was not lacking. From the shaft sunk forty feet last spring nearly enough gold was taken out to pay all debts. The claim extends one thousand five hundred feet on the lode line with a width of six hundred feet, with an additional one thousand feet by a less width not exactly stated. Eight hundred feet in from the mouth of the tunnel is a four-foot vein, which yielded $40 per ton. The new tunnel has cost at least $2,000.

Altitude	2,800 feet.
Course of vein	North and south.
Dip	Westerly, 45 to 90 degrees.
Average width of vein	1 foot.
Length of tunnel	1,370 feet.
Vertical depth in tunnel	225 feet.
Depth in inclined shaft (old)	200 feet.
Hanging-wall	Granitoid.
Foot-wall	Granitoid.

CAÑON CREEK DISTRICT.

CAÑON CREEK MINE.

This mine is situated on the South Yuba River, at the mouth of Cañon Creek. The vein here, which varies from four to six feet in thickness, and is traceable for five thousand feet, has a north and south course, and an easterly dip. Several short tunnels have been driven on it, and a shaft put down to a depth of seventy-five feet is all in good ore, considerable quantities of which have been milled with satisfactory results.

BLUE JAY MINE.

This claim is situated one mile east of the Cañon Creek Mine, and on a parallel vein, which occurs in a granitic formation, and has an average width of three feet. A tunnel has been driven on the vein two hundred and ninety feet, cutting an ore body one hundred and eighty feet long. The ore is being worked in the Yuba Mill.

THE CHASE CLAIM.

The claim is situated two miles below the Boorman Dam; shows a four-foot vein coursing east and west, in contact of granite and slate. A cross-

cut tunnel has been driven on the vein, and a drift extended in it one hundred feet, work having been begun last fall. The ore gives good prospects in a hornspoon.

CANADA HILL DISTRICT.

MAYFLOWER MINE.

This property is situated two miles southeast of Nevada City, and consists of various claims relocated and consolidated in 1881. The vein here runs south of east by north of west, with southwesterly dip of 30 degrees, and a very variable width, the average being about eighteen inches. The quartz claim includes a length of one thousand five hundred feet, with a breadth of fifty feet; but the owners have one hundred and ninety acres of the surrounding ground located for placer mining. Within the limits of the claim there are two pay shoots, respectively one hundred and twenty and two hundred feet long. The mine is opened by a tunnel six hundred feet long, to a depth of one hundred and twenty-five feet from the surface. Another tunnel, now in six hundred and twenty feet, will cut the vein one hundred and ten feet deeper. The walls are granite near the contact of slate. The formation passed through in the crosscut tunnels is also granite. But little timbering is required. The ore is as usual in this section quartz, free gold, pyrites, galena, and zinc blende. It is wet crushed in a mill of four stamps weighing nine hundred and fifty pounds each, which drop seven to eight inches eighty to eighty-five times per minute, having an average duty of two and five tenths tons per stamp every twenty-four hours. The shoes and dies are of iron, costing 4½ cents per pound at the Nevada foundry. The screens are round punched, No. 6. The amalgamated plates, three in number, are, respectively, four by three and one half feet, six by three and one half feet, and six by two feet, supplemented by a plate three and one half by four feet, mounted on one of the two concentrators—one a Frue and the other a Triumph. The battery is supplied with ore by a so called box feeder; the crushing capacity of the mill being, as in many other instances, in excess of requirements, is operated only at intervals. When working, about 66 per cent of the recovery of free gold is obtained from the mortar, and the remainder from the plates. The mill is driven by two Pelton wheels with fifteen miner's inches of water, six-inch pressure, under one hundred and seventy feet fall; water free.

In the Mayflower proper the first pay shoot above the upper tunnel, more in on the vein, has been stoped out. The lower tunnel, which runs for one hundred feet in the vein, will have to be advanced four hundred feet to reach the shoot. The croppings of the Beckman, another vein on this property, have been worked on a length of seven hundred feet to depths varying from fifty to two hundred and fifty feet; also by four shallow tunnels, one shaft and by a deep crosscut tunnel, and drifts extending each way from one hundred and twenty-five to one hundred and sixty feet. On several other veins in this group some work is being done. The mine employs twelve men at $3 per day each.

Altitude	2,950 feet.
Length of pay shoots	120 to 200 feet.
Vertical depth reached	125 feet.
Number of stamps	4
Weight of stamps	950 pounds.
Drop of stamp	7 to 8 inches.
Drops	80 to 85 per minute.
Duty of stamp	2.5 tons in twenty-four hours.
Kind of screen	No. 6, round punched.

MEADOW LAKE DISTRICT.

EXCELSIOR MINE.

This is the only mine in this district on which much work is being done. A ten-stamp steam mill has been operating a portion of the past summer on ore from this mine, the Morris process being employed for recovering the gold. From a clean-up of one hundred and fifty tons of ore, there is reported a total product of $900, being at the rate of $6 per ton. Cost of mining and milling, $2 50 per ton; net profit, $3 50 per ton. This mill has no plates connected with it. The pulp is run on a large canvas, with strips of wood fastened lengthwise on it. The heavier material is removed from the canvas and carried to a large tub, where amalgamation takes place; it being claimed that all the free gold is saved by this method. It is noticed that the value of the ore here is not large; but, being easily extracted and cheaply milled, it seems to afford a fair profit. The sulphurets will not pay expense of recovery.

Number of stamps	10
Weight of stamps	900 pounds.
Drop of stamps, inches	7
Drops of stamps, per minute	85
Duty of stamp	3 tons crushed in twenty-four hours.
Kind of metal used for shoes and dies	Iron.
Number of men in mine	11
Number of men in mill	4
Average wages paid in mine	$3 per day.
Average wages paid in mill	$3 per day.
Length of tunnel in on the vein	30 feet.
Width of the vein	20 feet.

DRIFT GRAVEL MINES.

NORTH BLOOMFIELD MINE.

This property, which is situated three fourths of a mile southwest of the town of North Bloomfield, at an altitude of three thousand one hundred and fifty feet, is a consolidation of many claims, the whole aggregating one thousand five hundred and thirty-five acres. Of this area about one fourth consists of auriferous gravel resting in ancient river channels. About one half, perhaps, of these deposits has been worked out. The general course of the main channel is northeast and southwest; its course is, however, variable, its bearing at the present point of working being toward the northwest. The formation traversed is black slate. The company has driven ten thousand one hundred and thirty-five feet of tunnels, at a cost of $798,000, besides an open cut of two thousand feet in length. A portion of the tunnel run fourteen years ago cost at the rate of $27 per foot. A crosscut nine feet wide by nine feet high, not counting track, air pipe, etc., cost $26 16 per foot by hand drilling, and $21 40 per foot where Burleigh drills were used. Also forty-five miles of ditch have been constructed at a cost of $500,000, and reservoir for water storage at an expense of $250,000. The claim has been worked in all about thirty years, the deep channel fourteen years. The pay channel here is four hundred feet wide, and the gravel contains a large proportion of white quartz pebbles and cobbles with masses of ferruginous conglomerate and blue quartz bowlders, which seem to have had their origin in the immediate vicinity.

The blue gravel is about one hundred and thirty-five feet deep, some of it being so cemented that it cannot be washed until blasted, requiring

often further breaking up with sledges. This claim is worked by hydraulic process, two monitors of six-inch nozzles and one of seven and a half-inch nozzle being employed; also a Hendy's hydraulic gravel elevator with a vertical height of ninety and six tenths feet, an inclination of 60 degrees from the horizon and a diameter of the up-cast pipe of twenty-two inches. The nozzle by which the elevator is operated has a diameter of six and a half inches, and delivers one thousand four hundred miner's inches* of water under a pressure of five hundred and thirty feet. The quantity of water used for piping is six hundred and twenty-five miner's inches, all of which, together with the gravel washed, is raised by the elevator to a flume which conducts it to the reservoir. The reservoir is formed by building a dam, twenty feet thick, of small pine trees, interlaid with gravel across a worked out portion of the claim, thus inclosing a space several hundred feet wide, and some two thousand five hundred feet long, in which to impound the tailings. The dam is thrown across the space between the banks at a considerable distance from the mouth of the drain tunnel and including that in the reservoir.

At a distance of fifteen hundred feet from the dam is the discharge for the water, consisting of a cribbed and planked shaft or vertical conduit, which connects with the drain tunnel. The dam is forty feet high, but was built up at intervals as the debris accumulated behind it so as to maintain a sufficient depth of water at all times to permit the settling of sand and gravel, while the water passed through the outlet to the drain tunnel; the shaft forming the outlet, being also built up proportionally with the dam from time to time. The inlet to the reservoir (or one of them, for there are two) is close to the dam, and whenever the dam is raised the stream of water and gravel is caused to flow into the reservoir close to it so that the coarser gravel settles against the dam and forms a part of it. At this time the top of this dam, including the coarse gravel adjoining it, forms a strip of dry land at least one hundred feet wide.

The reservoir has now a maximum depth of one hundred and twenty feet of water at a point which is further from the dam than the present outlet. Here a new outlet two thousand three hundred feet from the dam is being constructed in order to utilize the entire area of the reservoir. The company has about six thousand feet of hydraulic pipe in use with from three hundred and fifty to five hundred and thirty feet fall. The mine employs twenty-five men at $2 50 per day. The gold obtained is of a "shotty" character, varying in fineness from 898 to 936; that from the deep channel is coarser and lower in fineness, as is usually the case in gravel mines. From January, 1876, to January, 1884, during which time the mine was worked as an open hydraulic, the output amounted to $2,000,000. In January, 1884, the mine was enjoined in the suit of Woodruff against the North Bloomfield Gravel and Mining Company and others, and has since remained closed except as worked by the present ineffectual and costly method.

Altitude	3,150 feet.
Length of tunnels	10,135 feet.
Cost of tunnels	$798,000
Length of ditch	45 miles.
Cost of ditch	$500,000
Cost of water reservoir	$250,000
Diameter of hydraulic elevator	22 inches.
Vertical height of hydraulic elevator	90.6 feet.
Inclination of hydraulic elevator	60 degrees.
Diameter of hydraulic nozzle	6½ inches.

*Bloomfield measure, which is six inches pressure above the upper edge of a two-inch slit.

Length of hydraulic pipe in use	6,000 feet.
Quantity of water for piping	625 miner's inches.
Fall of water for piping	350 to 530 feet.
Quantity of water for elevator	1,400 miner's inches.
Fall of water	530 feet.
Width of debris dam	29 feet.
Height of debris dam	40 feet.
Length of tailings reservoir	2,500 feet.
Width of tailings reservoir	Not ascertained.
Greatest depth of water in tailings reservoir	120 feet.
Number of men employed	25
Wages paid	$2 50 per day.
Fineness of gold, about	900
Gross production of mine from 1876 to 1884	$2,000,000
Gross production since 1884	Not given.

DERBEC DRIFT GRAVEL MINE.

A consolidation of several claims is now owned by the Derbec Blue Gravel Mining Company, incorporated in 1877. This mine, which is situated one mile northwest from the town of North Bloomfield, covers an extent of six hundred and twenty-one acres. As with this class of deposits generally, the channel here has a devious course; where now being exploited it points easterly.

This mine is worked from a shaft having a vertical depth of four hundred and sixty-six feet. In its downward course it passes through two hundred feet of "lava cement," followed by a series of beds of clay, sand, and fine auriferous gravel. The bedrock is soft slate for a distance of two thousand feet back from the breast. In the lower part of the claim it is hard metamorphic slate. The gravel, which is not cemented, is extracted to a depth of ten to eleven feet, and in places sixteen feet. It is washed in sluices and has yielded on an average, $1 85 per carload of one thousand five hundred pounds, or $2 47 per ton; this being the average for eleven years, the whole time the mine has been worked, and includes waste, bowlders excepted. The daily extraction is two hundred and seventy carloads, equal to two hundred tons. The first washing is through six hundred feet of flume, the tailings being retained in the creek bed by a brush dam in order that they may "slack." This effected, the dam is cut and the accumulated mass is ground-sluiced into a flume four thousand feet in length, adding 10 per cent to the total yield of the first six hundred feet of flume. Below the four thousand feet flume the tailings are again arrested by a large dam of brush and trees. There are many of these retaining dams; the four thousand feet flume extending under them all. A bedrock tunnel is being driven to reach this point from a point one thousand seven hundred feet distant, and is now in one thousand three hundred feet. This will admit of another two thousand feet of flume, through which the tailings will be washed, and afterwards impounded on a piece of worked out hydraulic ground. The grade of the creek bed along which the flume is laid admits of, and indeed necessitates, several falls of ten or twelve feet each; these are very effective in cleaning the cobbles and disintegrating any cemented matter, of which there is always some in every gravel mine.

These flumes are two feet wide and two feet deep, with a grade of eleven inches in each twelve feet. The riffles are iron slat, Hungarian, old car wheels, and rocks. Monitors are employed on the washing dump with three hundred inches of water of one hundred feet fall. Quicksilver is used in the lower portion of the first flume. A clean-up is made every two weeks, which frequency is rendered necessary by the ferruginous character of the water, which tends to form a hard cement with the gravel in the sluices. In addition to the main washing dump there is a small one used

for the purpose of prospecting the gravel from different parts of the mine. The Superintendent says it would be even better to have two such small washing dumps, as it is not possible to judge from appearances whether the stuff from different depths, or from different sub-channels, will or will not pay.

The tailings from the small washing dump and its connected short line of sluices flow into the main flume; the bowlders which are brought up have gravel adhering to them and are dumped in piles and exposed to the weather for a time, after which the gravel is easily removed and is collected and washed. The gravel is much mixed with a soft granite, which somewhat reduces its value. This mine is especially characterized by granite bowlders, both hard and soft, and very numerous; also by masses of a peculiar, soft, greenish, siliceous rock. The granite bowlders seem to have come a long way, there being no granite of the same kind nearer than Eureka.

The width of the pay channel at the present point of working is from six hundred to seven hundred feet. It has been found as small as one hundred and seventy-five feet at some points. It has been worked up stream a distance of three thousand five hundred feet in a straight line from the shaft, a length of seven thousand feet following the curves.

The tunnel is not advanced beyond the immediate requirements for breasting, and not being in bedrock, but in gravel, pillars are left to support the roof. This channel has a heavy grade. A large part of the labor of working it consists in transporting cars, timbers, etc., to the breast, which is done by means of mules.

The water, amounting to about ten miner's inches, drains out through a tunnel, driven for the purpose of working a portion of the channel attempted at one time to be worked by a new shaft, down stream from the main shaft, but so much water was encountered, that the drain tunnel became a necessity and now serves to drain the whole mine.

The object in working from a shaft is to obtain grade for washing and storage for tailings, the latter a point of great importance. The mine is ventilated by a Baker blower, driven by a Pelton water wheel; there being also an engine, which may be used for the purpose. The air pipe reaches the main shaft at a depth of sixty feet through a tunnel. The design in this arrangement is to insure a continual air supply to the mine in case of the burning of the hoisting works; also, in such event, to afford means of escape for the miners—an example which should be followed in other and similar situations.

The hoisting works contain a forty-horse power steam engine, with two boilers, and are well arranged and equipped. Flat cables are used, and one car comes up as another goes down, which saves one quarter of the cost of hoisting, and lessens the strain and shock on the machinery. Safety cages are employed, and the shaft remains covered by a bonnet until a cage comes up, and in this wise accidents are avoided. There is a Cornish pump of ample power in readiness, but there has been no occasion for using it since the drain tunnel was opened. For hoisting, three cords of pine wood are consumed daily, at a cost of $2 85 per cord delivered. This is a rather dangerous mine to work, the gravel being loose, and bowlders numerous, while the roof is sandy and requires timbers for its support. These, being indispensable, form a considerable item of expense. Various kinds of timber are used. Posts, brought from a distance of two miles, cost 3 cents per running foot, delivered at the mine. The sum of $50,000 was expended before pay gravel was reached.

The company employs from ninety to one hundred men, paying the ordinary miner $2 50 per day; timber men, repairers, and special miners, $3 per day. No Chinese are employed.

Depth of shaft	466 feet.
Nature of pay gravel	Free.
Nature of bedrock	Slate.
Depth of gravel drifted	11 feet.
Pay	$1 85 per car (1,500 pounds).
Length of time worked	11 years.
Number of carloads extracted	270 per day.
Number of men worked	100
Wages	$2 50 per day.
The gross monthly product	$15,000
Grade of channel	Not stated.

MANZANITA.

Located in 1850, is situated one mile north of Nevada City, at an altitude of two thousand six hundred and seventy-five feet. The claim covers an area of two hundred and twelve acres. The general course of the lead is here northwest and southeast. The tunnel, three thousand feet in length, and constructed at a cost of $104,000, cuts through quartz, gravel, and cement. The bedrock is granite, as are also the only bowlders found in the mine. The average depth of the gravel drifted out is four feet. One hundred carloads of one ton each are being taken out and washed in sluices daily. All the drifts are thoroughly timbered with pine, found near by, and costing 4 cents per running foot. A very little water is met with. The mine employs twenty-five men, at $2 50 per day. Besides the tunnel, the company has constructed eleven miles of ditch and flume and laid down three thousand feet of twenty-two-inch iron pipe. A piece of ground, eleven thousand by one hundred and fifty feet, drifted out here some twenty years ago, yielded $3,500,000. The output of this mine, while being worked by hydraulic process, amounted to $1,500,000. The gold is worth $17 60 per ounce. The gravel bank is, in places, four hundred feet deep, and a large area remains to be worked.

Altitude	2,675 feet.
Course of lead	Northwest by southeast.
Length of tunnel	3,000 feet.
Cost of tunnel	$104,000
Nature of pay gravel	Free, quartz.
Nature of bedrock	Granite.
Depth of gravel drifted	4 feet.
Number of men worked	25
Wages	$2 50 per day.

LAST CHANCE MINE.

The property, located one quarter of a mile east of the town of North Bloomfield, has an inclined shaft down five hundred and fifteen feet at an angle of 36 degrees, and a drift to the southwest four hundred feet in bedrock slate. Auriferous gravel has been struck, but the mine makes so much water that it becomes necessary to put in a steam pump. The hoisting works have a capacity of three hundred carloads per day; the motive power is obtained from a six-foot Pelton wheel, with thirty miner's inches of water and one hundred and ninety-six feet pressure. A vertical depth from surface of three hundred and five feet has been reached in the drift. Expenditures thus far, $20,000.

The Blue Gravel Mine at Moore's Flat employs seventeen men washing gravel. At Washington, parties are prospecting two gravel mines, employ-

ing three men. At Brandy Flat, one half mile from Washington, five men are employed in a drift; the gravel here being cemented, is crushed in a two-stamp mill.

PLACER COUNTY.

This county, so named from the Spanish word "placer," meaning a place where gold dust is found mixed with the sand, earth, or gravel, is bounded by Yuba and Nevada on the north, by the State of Nevada on the east, by El Dorado and Sacramento Counties on the south, and by Sutter on the west. Placer furnishes another example of the ill-shaped, ill-proportioned counties of the State of California, this, in proportion to its length, being the narrowest county in the State; its length being over ninety miles, while its average breadth is scarcely more than thirteen miles.

Extending beyond the summit of the Sierra Nevada, the eastern portion of this county reaches an altitude of over seven thousand feet, the surface of the entire eastern half being elevated and rugged. The other half, extending westward over the foothills, sinks into the great Sacramento Valley, its western border being hardly one hundred feet above the sea level. The middle and upper portions of Placer County are eroded by many deep ravines. The North Fork of the American River, coursing through a cañon two thousand feet deep, flows west through the center of the county. The Middle Fork of the same river, flowing through a cañon equally deep, separates this county from El Dorado. In the mountains are many streams, tributaries of the North and Middle Forks and of Bear River, which separates Placer from Nevada County. East of the Sierra Nevadas a part of Lake Tahoe lies within the limits of this county. The water supply of Placer, naturally large, has been supplemented through the construction of numerous ditches, several of them costly and of large capacity. The upper half of this county is covered with splendid coniferous forests, the central portion with a scattered growth of oak and scrub pine, the western portion being nearly treeless. Extensive lumber operations are carried on in the higher foothill regions.

MINING INTERESTS.

Placer has from the first been noted for the varied character and the extent of her mining operations and her large bullion production, the latter having at one time amounted to several million dollars per annum. Of late years the output of gold has been greatly diminished, through the stopping of hydraulic mining, formerly prosecuted here on a large scale. Meanwhile, however, drift gravel mining has been somewhat increased. This branch of the business is now largely carried on in the county, the Forest Hill Divide being the site of its most extensive operations.

Besides gold in every form of deposit, Placer possesses other mineral resources, some of which are being largely utilized. Among these are chrome iron, granite, marble, iron, etc. Placer is also beginning to take high rank as a fruit and grape growing county. Her fine climate and rich soil, coupled with superior irrigation and transportation facilities, insuring for her special advantages for the prosecution of this industry, to which so much attention has been given of late.

QUARTZ MINES AND MILLS.

AUBURN DISTRICT.

This branch of mining has, for the past year, been rather inactive in and about Auburn, most of the work done being in the nature of prospecting and assessment work. The new five-stamp mill in Auburn ravine, near the Ohio Mine, has been running on ore from that mine. The Gold Blossom, ten stamps, the Shipley, ten stamps, the Pelster, five stamps, and the Thirty-one Mill, all in the same vicinity, have, for various reasons, been idle most of the time.

THE BELL MILL.

At Bald Hill, three miles northwest of Auburn, A. O. Bell has been running a Kendall National Rocker, No. 2, operated by an overshot wheel twenty-four feet in diameter, with ten inches of water, costing 10 cents per inch, $1 per day. This quantity of water, however, supplies the mill. The ore worked is from various small rich veins in the vicinity. This rocker receives pieces the size of a hen's egg, and, with a No. 7 diagonal slot screen, treats from seven to ten tons of rock in twenty-four hours. Mr. Bell, who has had much experience in building and working stamp mills, is of the opinion that this rocker will work more ore and do it better than any stamp mill. He furthermore states that he works raw sulphurets (blanket washings from the mill) almost up to the fire assay.

In working quartz the mill is fed continuously with ore and water; but when working concentrates the screens are replaced by two-inch plank, in which are three half-inch plugholes at different levels. The mill is charged with five hundred pounds of sulphurets, and water enough added to make a rather thin pulp; quicksilver is also added. The rocking is then continued until the ore is finely ground, or rather crushed, for the action of this mill is similar to that of rolls. The upper plug is then removed and the pulp withdrawn. The plug being replaced, more water is admitted, and the working continued some time longer, when the next lower plug is taken out, and so finally the lowest, after which the mill is again charged as before. The roller weighs from one thousand five hundred to one thousand eight hundred pounds; but the next new set of shoes will make the weight one ton, which is equal to the weight of the mortar or cradle. This mill costs $500, including iron in the rocker and the water wheel, also the toothed segment for the latter, and the gear wheel for connection with the rocker. There are no belts, though Mr. Bell thinks a belt would be better than the toothed gear.

As to the proportion of gold recovered in the rocker, this gentleman says he obtained $320 to $5 on the plates. This, however, must depend partly on the coarseness of the gold, although it seems likely that the rolling action of this style of mill will not cut the particles of gold as much as the revolving stamp mill. A plate of amalgamated copper is placed on the lip of the mortar, which forms an arc of a circle, the plate being bent to fit. There are also in use here copper-plated sluices, as in a stamp mill. This is the simplest gold mill in use, and seems to be efficient. According to Mr. Bell, it will not cost more than $65 per year to keep the machine in running order. A set of rings for the roller mill lasts twelve months. Two sets of dies are required to one of rings.

BUTTES MINE.

This mine, located three fourths of a mile southwest from the town of Ophir, in Ophir District, covers a surface area of one thousand five hundred by six hundred feet. Course of vein, east and west; dip, southerly, at an angle of 45 degrees; thickness, four feet. Length of pay shoot, one thousand two hundred feet, so far as developed. Hanging-wall, a talcose slate; foot-wall, porphyry. This mine makes but little water. The croppings have been extracted to a depth of eighty feet for a length of one thousand two hundred feet. A tunnel eight hundred feet long cuts the vein at one hundred and eighty feet from the surface, and a winze has been sunk to a further depth of forty feet. Ore to the amount of one thousand five hundred tons has been extracted. A contract has been let to drive the tunnel for $6 per foot, the contractors furnishing powder and light, the company supplying tools.

The company has made three fourths of a mile of ditch, and a like length of road, besides branch roads about the mine. The ore is quartz, containing about $8 per ton of free gold, but the chief value is in the sulphurets (pyrites and galena), which, beside gold, carry much silver. The method of treating the ore is by wet stamping and amalgamation in a five-stamp mill, driven by an overshot water wheel. Seventeen men are employed, at an average of $2 50 per day each. Projected improvements are boarding and lodging houses for a large force of men, and a twenty-stamp mill to be run by a Pelton water wheel, water to be brought from Bear River, with about one hundred and seventy feet of fall.

Average width of vein	4 feet.
Length of pay shoot	1,200 feet.
Average value of ore per ton in free gold	$8
Length of tunnel	800 feet.
Vertical depth reached	210 feet.
Length of road built	$\frac{3}{4}$ mile.
Length of ditch built	$\frac{3}{4}$ mile.
Number of stamps	5
Number of men employed	17
Wages	$2 50 per day.

ST. LAWRENCE MINE.

This mine is one half mile northwest of the town of Ophir, at an elevation of six hundred and fifty feet, including an area of one thousand five hundred by six hundred feet. The vein here has an east and west course, dips to the south, and so far as explored has an average thickness of eighteen inches. The length of the ore shoot is one hundred and twenty-five feet. This consists of a stringer running nearly parallel with the main vein, on which are four ore shoots. This stringer is worked by a tunnel, which follows it a distance of two hundred and sixty feet. The walls are granitoid—more accurately protogenic gneiss, a stratified rock consisting principally of quartz and talc.

The vertical depth reached in the tunnel is one hundred and fifty feet. Cost of tunnel, $6 75 per foot, with single hand drilling and Giant powder, No. 2, of which forty pounds are consumed monthly in driving and also in stoping. The tunnel is advanced one foot per day by the work of two men. Timber, used only for the shafts, costs $18 per thousand for pine, brought from a distance of three miles. The ore is quartz, with iron and copper pyrites and galena. The ordinary class of rock is worked by wet stamping and amalgamation in the adjacent St. Patrick Mill, leased for the purpose. That which is heavily charged with sulphurets is selected

and sent to the reduction works at Reno, at a cost of $30 per carload for freight. The charge for smelting is $14 per ton, the price paid less working charge is 95 per cent of the assay value in precious metal. The above mill has fifteen stamps of seven hundred and fifty pounds each, dropping from four and a half to five inches at the rate of eighty drops per minute. The shoes and dies are of steel, costing $120 per set, from Pittsburg. One set crushed one thousand two hundred tons of ore, thus costing 10 cents per ton of ore crushed. The fifteen stamps crush one and two tenths tons each per day of twenty-four hours.

The mill is worked at intervals only, as ore is accumulated. The screens are wire gauze No. 40 and round punched No. 6, with a length of thirty-six inches by a height of five inches, and are fixed in a vertical position. The aprons are forty-two inches in width at the upper ends and eighteen inches at the lower, with a length of six feet. The plated sluices are five inches wide by fourteen feet long to each battery. The plates are silvered. Inside mortar plates are also used of the length of the mortars and four and a half inches high. The mill is furnished with two Hendy feeders, one Brodie rock breaker (sixteen inches), six Hendy concentrators, one Knox pan, one Wheeler pan, and two settlers. The pans are used in working the concentrates, by amalgamation with the aid of nitre and sal ammoniac; but in general it pays better to ship the sulphurets to Reno. Nearly the whole of the amalgam recovered is found in the batteries. The sulphurets assay from $70 to $200 per ton; two thirds being gold and one third silver. The mine now employs three men at $2 50 per day each. The mill when working employs two men, who are paid $3 a day each. The mill is driven by a Knight wheel, with eighty inches of water at six-inch pressure and one hundred and sixty feet fall, costing 10 cents per inch per day.

Altitude	650 feet.
Length of ore shoot	125 feet.
Vertical depth reached in mine	150 feet.
Length of tunnel	260 feet.
Cost of tunnel	$6 75 per foot.
Number of stamps	15
Weight of stamps	750 pounds.
Drop of stamps, inches	4½ to 5
Drops of stamp, per minute	80
Duty of stamp	1.2 tons in 24 hours.
Kind of shoes and dies	Steel.
Cost of shoes and dies	$120 per set.
Cost of shoes and dies, per ton crushed	10 cents.
Kind of screens	Wire, No. 40; round punched, No. 6
Dimensions of apron	6 feet long and 18 to 42 inches wide.
Plated sluices to each battery	14 feet long and 5 inches wide.
Kind of feeder	Hendy, No. 2
Kind of rock breaker	Brodie.
Kind of concentrator	Hendy.
Number of men employed	3
Wages	$2 50 per day.
Water used for power	80 miner's inches.
Cost of water	10 cents per miner's inch.
Fall of water for power	160 feet.
Kind of water wheel used	Knight.

RISING SUN MINE.

This mine is situated in Illinois District, about one mile northwest of the town of Colfax, being on the same quartz belt that extends north through Grass Valley. It is an early location, has been extensively and systematically worked, has been a large producer of bullion, and is well equipped with plant. Work on the property is stopped on account of litigation.

The mine is opened by a vertical shaft to the depth of three hundred feet, when the vein dips to the southward and is followed six hundred feet by an incline shaft, all timbered. The walls are granite. The mine makes a great deal of water, which, when working, was raised by a Cornish pump. The ore is quartz, with free gold and pyrites, and is treated by wet crushing and amalgamation. On the mine is a mill with twenty stamps of nine hundred pounds weight each, with a drop of five inches eighty times per minute. The duty per stamp in twenty-four hours was one ton, through a wire screen of sixty meshes to the running inch. The shoes and dies are of cast-iron. The feeders, the Hendy Challenge. The apron plates are silvered. There are four Frue concentrators in the mill. The concentrates were sent to Nevada City for treatment by the chlorination process. The mine, when worked, employed thirty men at $3 per day. This mine has yielded $2,000,000.

Altitude	2,290 feet
Length of ore shoot	500 feet.
Depth of ore shaft on incline	900 feet.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Shaft timbered	900 feet.
Number of stamps	20
Weight of stamp	900 pounds.
Drop of stamps, inches	5
Drops of stamp, per minute	80
Duty of stamp	1 ton in twenty-four hours.
Kind of screen	Wire, No. 60.
Kind and number of feeders	Hendy, 4
Kind and number of concentrators	Frue, 4

BIG OAK TREE MINE.

This property was located in 1886 as the "Milford," and relocated in July, 1883, under the present name; is situated in the Illinois District, about one mile west of Colfax. Stopped working on May 7, 1888, on account of litigation, and has not yet (June 13, 1888) resumed; consequently the mine cannot be examined, being full of water.

The following information as to the mine was given by Joseph Werry: Course of vein, northeast and southwest, and dips to the northward 80 degrees; average width, sixteen feet. The length of the pay shoot is not known. The mine has one vertical and two incline shafts, the deepest (on the slope) being one hundred and eighty feet. The walls are crystalline rocks of granitoid character, highly siliceous. The cost of extracting ore was about $6 per ton, and the sinking of the shaft cost $20 per foot, including timbering, guides, etc. It was sunk at the rate of nine feet per week, six men working. The entire length is timbered with pine, at 10 cents per running foot, the timber having been cut on the ground. The company has built one half mile of road for the purpose of hauling the ore to the mill of the Rising Sun Mine adjoining. To transport the ore to the mill cost 25 cents per ton by wagon. The ore is quartz with free gold, which is often visible to the naked eye, and a little pyrites. It paid $25 per ton in free gold. It was shown, in the evidence given in Court, that prior to the destruction of the old hoisting works by fire, in August, 1887, the mine had paid a profit of $30,000 since its relocation in 1883. The present hoisting works are new and good, and cost over $5,000. The mine is at present under injunction, pending a decision as to whether the land is mineral or agricultural, it being on a railroad section (33).

THE GOLDEN EAGLE

Is another mine on this property, and is said to be the extension of the Rising Sun. There is a shaft on the vein seventy feet deep, showing a vein eighteen inches wide, but not of paying quality so far. The strike of this vein is northeast and southwest.

The Werry is the extension of the Golden Eagle. It has a crosscut tunnel in three hundred feet to the vein, and a drift on the vein. No ore milled yet. Yet another mine owned by the same parties, or some of them, is the Little Pine. It is an extension of the Big Oak Tree. Nothing more than annual work has been done. All of these mines are on the same quarter section. The situation is very advantageous for a deep tunnel from Bear River, on the Golden Eagle, and thence to the Rising Sun, with crosscuts to the other mines. There is a good mill site on the river, owned by S. D. Valentine & Co. Water power can be obtained from the river to operate a large mill.

NEWCASTLE DISTRICT.

KIDD & JOHNSON MINE.

This mine is situated one and a half miles northwest from the town of Newcastle. Course of vein, nearly east and west; width, twenty-four inches; dip, south 35 degrees. Ore: quartz, galena, pyrites, free gold. Incline down eighty feet, for the purpose of cleaning out mine, the former workings of which have caved in. A good deal of water is met with, requiring the services of a four-inch pump. This pump, similar to the Cornish, is worked by a ten-foot overshot wheel, thirty inches of water being used to pump and hoist. The shaft is timbered. The claim is on a United States patent for agricultural land. There is another parallel vein on the land, from eight to ten inches wide, carrying free gold. The Pugh Mill is idle at present, but is to be started soon on custom work at $2 50 per ton. This mill, which is driven by an overshot wheel thirty feet in diameter and thirty inches breast, using forty-five inches of water, has five stamps of six hundred and fifty pounds weight each.

DRIFT GRAVEL MINES.

DARDANELLES MINE.

The mine is situated one mile southwest from the town of Forest Hill, in Forest Hill District; embraces a tract of 312.77 acres. The ground is opened by a bedrock tunnel two thousand feet in length, driven at a cost of $10 per foot through a slate formation. At about six hundred feet from the entrance the tunnel cuts a fissure in the slate, having a course north 15 degrees west, and south 15 degrees east, that of the tunnel being north 34 degrees west. The fissure, which is two feet wide, is filled with quartz, in bunches, and a soft, gray mass of volcanic ash. The vein is visible on the present surface, where formerly lay a bed of gravel, which has been washed off, for this was once an hydraulic mine. It is stated that the vein penetrated some distance into the gravel bed. The stratum of pay gravel in this mine, which is five feet thick, is a very hard cement, requiring to be crushed with a stamp. The channel contains a considerable number of bowlders. Resting above the gravel is a bed of coarse gray sand, so firm that a post only here and there is required in the breast.

The mine is ventilated by a No. 5 Sturtevant blower. The tunnel supplies the greater part of the water required in the battery for working the gravel.

This ground has been worked thirty-six years, mostly by the hydraulic process. The width of the pay channel now being drifted on is not known, but the breast is seventy-one feet in width, gold being visible on the cobbles. From forty to forty-three carloads of twenty cubic feet each are extracted in each day of twenty-four hours. The timbers used are round pine sticks, costing 1 cent per running foot for the cutting, and 1½ cents for the hauling from a distance of half a mile. The mine employs thirty men, at $3 per day for miners, and $2 50 per day for carmen. The mill contains five stamps of nine hundred and thirty pounds each, which drop seven and one half inches, from one hundred and one to one hundred and four times per minute, crushing nine hundred cubic feet of cement per twenty-four hours, through a round-punched screen, holes three sixteenths of an inch in diameter; dimensions of screens, inside of the frame, fifty-four inches by twenty. The battery requires seven miner's inches of water, and is supplied with gravel by a Hendy feeder. The shoes and dies are of cast-iron, costing 7 cents per pound at the foundry. Steel is to be used in future. The apron is twelve feet long by sixty inches wide, and is plated for three feet near the battery; inclination, three fourths of an inch to the foot; plate not silvered. Beyond the plate the apron has four transverse grooves, about an inch wide and half as deep, filled with quicksilver. Quicksilver is also used in the battery. The pulp passes from the apron to the Eureka rubber, and thence through ripple sluices. On panning some of the material passing from the rubber, no gold was seen. The gravel contains a considerable portion of pyrites, but whether they are auriferous or not is not known. The recovery from the different parts of the mill is divided as follows: In battery, eighty-seven; on plate, seventy-one; in rubber, five and one half, and in the sluices, one and one half per cent. The amalgam from the battery is worth much more per ounce than the other, being formed of coarse gold. The mill, which is new, and framed for ten stamps, went into operation May 18, 1888. The motive power required is obtained from a Pelton wheel, two feet diameter, with twenty inches of water, under two hundred and ninety feet pressure, obtained from Volcano Creek, and owned by the mill. Three men are employed in the mill, at $3 per day each. This property, formerly worked by hydraulic process, was paying well when further work upon it was enjoined by the Courts. The channel here is supposed to be identical with that of the Mayflower Mine.

Length of tunnel	2,000 feet.
Cost of tunnel	$10 per foot.
Nature of pay gravel	Cement.
Nature of bedrock	Slate.
Depth of gravel drifted	5 feet.
Length of time worked (in all)	36 years.
Number of men worked in mine	30
Wages in mine	$3 per day.
Number of men in mill	3
Wages paid in mill	$3 per day.
Number of stamps	5
Weight of stamp	930 pounds.
Duty of stamp	180 cubic feet in twenty-four hours.
Drop of stamp	7.5 inches.
Drops per minute	101 to 104
Size of screens	54 to 20 inches.
Size of holes in screens	$\frac{3}{16}$ inch.
Quantity of water used in battery	7 inches.
Quantity of water used for power	20 inches.
Fall of water used for power	290 feet.

THE BAKER DIVIDE MINE.

This claim is located three miles from the town of Forest Hill, on the point between Shirt-tail Cañon and Volcano Cañon. From the face of the adjacent cañon a tunnel seven by eight feet has been carried in three thousand three hundred feet. From the inner extremity of this tunnel an uprise one hundred and twenty-five feet has been made, from which drifting has been extended three hundred and seventy-five feet. It is proposed to carry this tunnel forward another five hundred or one thousand feet till it intersects the channel which, coming down the divide from the Damascus and and Waske Mines, passes through the Mayflower claim. This tunnel did not require timbering for the first one thousand five hundred and seventy-five feet; farther on, however, this became necessary. The ground has all to be blasted. Two of the National compressors, made at the Phœnix Iron Works in San Francisco, are employed for driving the drills. One of these is located near the office, four hundred feet above the tunnel mouth, and is driven by a fifty-horse power engine, the air being conveyed down the hillside to the receiver at the tunnel mouth by a two-inch pipe. This is used only when water is scarce. The other machine, located near the tunnel, is driven by a Knight wheel, placed two hundred and seventy-five feet further down the hill, which is so steep that a person can with difficulty stand on it. The power of the wheel is conveyed to the compressor by means of a wire rope. The water for the Knight wheel is taken from Shirt-tail Cañon and flumed around the almost vertical hillside a distance of three thousand seven hundred feet. This flume is built for the most part on the grade of the old Union ditch, made in 1850 to 1851 to carry water to Georgia Hill. The planks for the old flume were hewn out of trees, and their remains are still to be seen.

The long tunnel is supplied with air by a No. 5 Anderson noiseless blower, operated by a Knight wheel of twelve inches diameter, impelled by a jet of water under two hundred and seventy-five feet fall, through a five-inch to a two-inch pipe. It requires about four miner's inches of water, under the above pressure, to drive the blower at the required speed, which, however, is not by any means the maximum.

Owing to the steepness of the country, the installation of this plant must have been extremely laborious. The drill used is the National. The powder, Hercules, containing 40 per cent of nitro-glycerine.

Work was begun on this property three years ago, but some delay was occasioned by the failure of the water during the dry season, for which reason the steam engine was added to the plant last fall.

WASHINGTON GRAVEL MINING COMPANY.

This claim lies between the Breece and Wheeler and the Mayflower. Work was begun in the fall of 1883, when a shaft was sunk three hundred and sixty feet to bedrock, exposing about two feet of gravel. They then drifted northward about four hundred feet and found the bedrock to be level. They also drifted southeast three hundred feet, and north 60 degrees west nine hundred and fifty feet, when bedrock was lost. Fair prospects were got, but work was discontinued for a time.

The shaft is five and one half by twelve feet clear, has two compartments, and is well timbered. Of the drifts only that to the northwest is timbered, the other being in bedrock. The plant consists of two boilers fifty-four inches in diameter and sixteen feet long, a hoisting engine of fourteen-inch

cylinder and two-foot stroke, single-gear hoist, pumping engine, with fourteen-inch cylinder and three-foot stroke; also Wheelock's automatic cut-off, and two Cornish pumps of ten-inch bore and eight-foot stroke, which have been taken up since the stoppage. This plant is well housed, and every precaution is taken to prevent deterioration by rusting, etc., until it shall again be put to use. It cost $25,000 and is first class in every respect.

THE MAYFLOWER GRAVEL MINING COMPANY

Own a claim adjoining the Pine Oak. It is stated that this mine is bonded. The mill has been taken down for the purpose of removal to a point below the new tunnel. The mine heretofore has been worked by a shaft, which was expensive on account of the large quantity of water which had to be raised. At present nothing is being done, pending the duration of the bond.

BREECE AND WHEELER MINE.

This property, located near the town of Bath, in Bath District, at an altitude of two thousand eight hundred feet, comprises a number of claims, some of them taken up as early as 1856. The channel in this ground bears north 40 degrees west, magnetic, and has lately averaged a width of fifty feet. The tunnel is seven thousand feet in length, and cost on an average $8 per foot. The formation passed through is gravel, the bedrock being slate. The pay gravel is cemented and has to be crushed in a mill. The average depth extracted is seven feet. Average yield per carload of one and a half tons was $31, for the years 1882–3; that for later years is not given. At the present time the yield is about $9 per carload, and the extraction twenty-seven carloads daily. But little timber is required in the mine and cost only the cutting and hauling. About thirty inches of water issues from the tunnel. Bowlders are not numerous except in spots. Hercules powder.is used.

The mill has ten stamps of eight hundred and fifty pounds each, dropping ten inches, eighty-five times per minute, and crush twenty-seven carloads (forty and a half tons) in twelve hours, through a screen of iron wire meshes of one eighth of an inch clear opening. The screens are each four feet long and two feet high. The battery is fed by hand, the large cobbles being picked out and allowed to weather, before being washed in a flume four hundred feet long. There are no plates in this mill, but simply a wooden apron with eight transverse grooves about one and a half inches wide and one half inch deep, containing quicksilver: the inclination is three quarters of an inch to two feet. From the apron the pulp passes to the Eureka rubber, and thence through one hundred feet of ripple sluices. Of the amalgam obtained 75 per cent is found in the battery while the dies are new, decreasing to 50 per cent as the dies wear down, leaving less room for the amalgam to accumulate and remain undisturbed by the action of the stamps. From twenty to twenty-five men are employed in the mine at $3 per day. The mill employs three men at from $3 to $3 50 per day; four being engaged on outside work. The mill is worked by steam power, with a consumption of one and a half cords of wood in twelve hours.

Altitude	2,800 feet.
Length of tunnel	7,500 feet.
Cost of tunnel	$8 per foot.
Nature of pay gravel	Cement.
Nature of bedrock	Slate.
Width of pay channel	50 feet.

Depth of channel drifted	7 feet.
Pay per car (2 tons)	$9
Number of carloads	27 per day.
Gross daily product	$243
Number of men in mine	20 to 25
Wages	$3 per day.
Number of men in mill	3
Wages in mill	$3 to $3 50
Number of men on outside work	1
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamp	10 inches.
Drops of stamp	85 to 95 per minute.
Duty of stamp	9 tons in twenty-four hours.
Kind of screen	Iron wire, mesh ⅛ of an inch.
Size of screen	48 by 24 inches.

PIONEER AND LYNN MINES

Are situated one and a half miles from Damascus, in Damascus District. The Pioneer is an old location, and has in time past turned out a good deal of bullion. The claim, which covers an area of six thousand by six hundred feet, includes four separate veins, on which considerable work has been done. The present owners, James G. Fair and A. E. Davis, are making a good road to the mine, and propose erecting on it a forty-stamp mill.

The Pioneer vein was worked from 1854 to 1862, then abandoned until 1880. Two ore shoots were opened and worked to water level, paying from $8 to $40 per ton. The tailings will assay $10 per ton, and the concentrates $200 per ton. The north shoot has been stoped five hundred feet in length, the south shoot one hundred and thirty-five feet.

THE DORER MINE AND MILL

Are located on the North Fork of the American River, three miles northeast from Damascus. Vein, five to eight feet wide. Tramway from mine to ten-stamp mill on the river; latter driven by a Pelton wheel. Has tunnel on vein three hundred feet. Cost of milling and mining, $2 per ton.

THE SHERIDAN MINE

Is situated near the station of the same name, on the stage road half way between Auburn and Forest Hill. A vein of quartz, some of which is very rich, occurs here between slate and sandstone. There are rich stringers in the sandstone. The mine is worked in a small way by washing the soft ledge matter and pounding up the richest of the quartz in hand mortars.

MOUNTAIN GATE GRAVEL MINE.

This mine is in the town of Damascus, in Damascus District. Some of the claims of which the property consists were located as early as 1852. The ground of the present company comprises one thousand and four acres, traversed by two different channels. It is opened by and worked through a tunnel seven thousand two hundred feet long, constructed at a cost of $7 per linear foot, track, etc., included. The formation passed through is slate, which also constitutes the bed of the channel. The course of the channel is here a little west of south. The gravel is of the loose or soft variety, admitting of its being washed in sluices. It is drifted out up to an average of five feet above bedrock, and has yielded an average of $2 per carload for two years—a carload being one and three fourths

tons, and thirty-two carloads being extracted daily. The mine has been worked thirty-six years, during which time two acres have been hydraulicked and twenty-five acres drifted.

The channels, for there is here a double channel, are capped with "chocolate cement." That in the upper channel requires lagging; in the lower merely posts and caps. The timbers used are fir and pine, obtained at 6 cents per running foot, merely the cost of cutting and delivery, the trees growing on the property. The mine makes about sixty miner's inches of water per day. In the upper channel, containing "white gravel," consisting mainly of quartz, many large bowlders are met with, while in the lower channel the gravel is black, and but little quartz is found. The Superintendent believes the lower channel to be identical with that of the Red Point, or Golden River Mine. The upper tunnel was run in the white gravel six thousand feet, when a cross channel was encountered, occupying a level eighty-eight feet deeper. A new tunnel, one hundred feet lower, was then run in six thousand eight hundred feet, when a still lower part of the cross channel was found, making pumping necessary. A thirty-six-foot overshot wheel of twenty-six inches breast was put in and driven by water from the upper tunnel. This answered for a time, but, as work progressed, was found inadequate to deal with the increasing influx of water. A branch drift was then made to tap the deep channel, and another wheel and pump were put in, a thick wall of gravel being left between the two in order to prevent the water from the first opening finding its way into the second. The pumps now suffice to keep the water down (June eighth), but a more effective arrangement will soon be required. The upper channel is three hundred feet wide, the lower four hundred and fifty feet, so far as yet known. The mine is ventilated by means of the combined tunnels, aided, when necessary, by a fire in a furnace built for the purpose. The mine employs twenty men, at $3 per day each for whites, and $1 50 for Chinese. The gravel is washed in sluices in the ordinary way, by means of the water coming from the mine. The worn-out car wheels are utilized as riffles. There are also slat riffles, which are better. Quicksilver is used in the lower sluice boxes.

Altitude at tunnel	3,800 feet.
Course of lead	A little west of south.
Length of tunnel	7,200 feet.
Cost of tunnel (with tracks)	$7 per foot.
Nature of gravel	Free.
Depth of gravel (drifted)	5 feet.
Pay	$2 per carload.
Number of men employed	20
Wages	Whites, $3 per day; Chinese, $1 50 per day.
Gross production per month, calculated on stated average yield per carload and daily extraction	$1,920

HIDDEN TREASURE MINE.

This mine is situated four miles westerly from the town of Damascus, at an altitude of three thousand six hundred and ten feet. The claim covers about four hundred and eighty acres, and includes two miles of the channel, which, so far as developed, holds a north and south direction; and up to the present time (June eighth) has shown an average width of between four hundred and five hundred feet. This mine has been worked for about ten years, and is now operated through some eight thousand feet of tunnel traversing a slate formation. For fifty feet this tunnel has a double tramway. The mine is timbered all through with spruce and pine, an ample supply being near at hand. The tunnel yields sufficient water for washing

the gravel. Very little blasting is required. Ventilation is secured by means of a special air drift, extending to the end of the working tunnel. The cars, of which there are four trains of sixteen cars each, are drawn into the mine by horses, and come out by gravity, the grade being such as to make a brake necessary to prevent too high speed. The bed of the channel is slate. The gravel, which is of a loose character, is drifted to the depth of six feet, from three hundred to four hundred carloads, averaging one ton each, being extracted daily by the labor of one hundred and thirty-five men, at $3 per day each for whites, and $1 75 per day for Chinese, and yielding about $1 50 per carload. Quartz bowlders are abundant. The gravel is dumped into a chute and falls to the washing floor, whence it is washed into the sluices by a stream of water from a hose and nozzle, under a pressure of twenty feet. There are two sets of sluices, with an intervening drop of fifteen feet, the first set being three hundred feet long, the second much longer. These sluices are lined with blocks of spruce and worn-out car wheels, the latter being good riffles for coarse gold ore are used in the upper sluices. A little quicksilver is used near the lower end to retain fine gold. According to report this mine has paid dividends regularly for ten years.

Altitude	3,610 feet.
Length of tunnel	8,000 feet.
Nature of pay gravel	Free.
Nature of bedrock	Slate.
Depth of gravel drifted	6 feet.
Length of time worked	10 years.
Number of men employed	135
Wages, whites	$3 per day.
Wages, Chinese	$1 75 per day.

GOLDEN RIVER MINE.

This mine is situated a short distance below Damascus, at an altitude of four thousand one hundred and twelve feet, and comprises four claims, aggregating about two thousand two hundred acres. Course of channel at this point east and west; width, four hundred and sixty feet. Gravel was struck in November, 1887; the bedrock tunnel, two thousand feet long, having been commenced in July, 1886. The total length of tunnel to date (June, 1888) is three thousand three hundred and forty-nine feet. It is seven feet high and eight feet wide; cost $12 40 per foot, and was driven at the rate of nine feet per day, by the aid of a No. 44 Straight-line Ingersoll air compressor, and three Ingersoll Eclipse drills, driven by a seventy-five-horse power steam engine, fuel costing $3 per cord. The powder used is Giant, No. 2. The grade of this tunnel is three inches to one hundred feet. The tracks are of sixteen-pound "T" rails; cars drawn in and out of the mine by horses. Ventilation is secured by means of a No. 4 Baker blower, four thousand feet of eleven-inch main pipe and six hundred feet of seven-inch distributing pipe. A very neat device in this connection is a system of stand pipes two or three feet high from the main air pipe in the tunnel; the upper end of each is curved toward the tunnel mouth by means of an elbow and nipple, and furnished with a stopcock. When the tunnel is full of smoke from blasting first one and then the other of the pipes is opened and thus the smoke is blown out of the mine in a simple and expeditious manner. The position of the channel was determined before starting the tunnel by careful surveys, examination of the channel in the Damascus Mine, and by tracing the vein rock so far as practicable.

The mine shows a bedrock tunnel straight for over two thousand three hundred and forty feet; a depth of six to seven feet of gravel—in places twelve or fifteen feet, the channel being crosscut at every one hundred feet, from rim to rim. A pan of gravel, taken from the face of the advance drift to the eastward at four feet from bedrock, yielded about 12 cents worth of gold, equal to $6 to the carload. The gravel has been breasted out to the extent of four hundred feet square. The roof is lava, of the kind known locally as "chocolate cement," a term which sufficiently describes its appearance. It is so firm that but little timbering is required—simply single posts and caps; no lagging, except in a few spots in the tunnel, the posts being at least fourteen inches square. The timber used is spruce and pine, costing 6¼ cents per running foot, found growing on the property in abundance. Of water not enough flows from the mine to serve for washing the gravel, and a larger supply from this source is a desideratum. Bowlders are plentiful, not of quartz, but of diorite and porphyry. A peculiar dark and light-striped bowlder is characteristic of this channel.

It is intended to open this mine by another tunnel, two miles further up stream. The gravel here is of the kind known to miners as "free"—that is, not cemented. It is now being taken out at the rate of three thousand carloads per month. The portion that has been washed has yielded $2 per carload of twenty-two cubic feet. This, however, has included much bedrock, cut out in leveling the tracks, also roof lava, which it was necessary to remove. This waste stuff, having been passed through the sluices, helps to swell the number of carloads, without adding much to the total yield. The gravel is washed through two hundred and fifty feet of sluices, which will soon be added to. The "riffles" are alternately slat (iron) and Hungarian. A partial clean-up is made every two days. A little quicksilver is used in the lower sluice boxes. The gold is scale or river gold, the largest nugget found being about $1. The fineness is from 929 to 931. There is a considerable quantity of black sand, part of it magnetic, and iron pyrites, some crystals of the latter being as large as an inch cube. This material is rich, and means are to be taken to save it more completely than is now being done. It has not yet been fully determined whether the gold in this material is really free, being merely mixed in a more or less finely divided state, with the black sand and pyrites; or whether a considerable portion of it is inclosed in the grains of sand or crystals of pyrites.

The Superintendent thinks the pyrite comes mainly from the slate, and contains no gold of consequence. Certain it is, the country rock abounds in sulphurets, yet it is known that sulphurets occur in the gravel in some mines, being apparently produced by reduction of iron sulphate in percolating water, by organic matter, as wood, etc., existing in the gravel, sulphurets so formed being often auriferous, both in this country and in Australia. Nor must it be hastily assumed that any organic matter which may have been originally buried in this gravel must necessarily have disappeared long ago. There is now a cedar trunk to be seen imbedded in the "chocolate cement" roof of this mine in a perfect state of preservation; not petrified, but only blackened.

Altitude	4,112 feet.
Length of tunnel	3,349 feet.
Cost of tunnel	$12 40 per foot.
Nature of gravel	Free.
Nature of bedrock	Slate.
Depth of gravel drifted	6 feet.
Pay per carload	40 cents to $6.

Length of time worked	7 months.
Number of men employed	50
Wages (whites)	$2 50 to $3 50 per day.
Wages (Chinese)	$1 75 per day.

HOGS BACK MINE.

This mine, located near the Golden River property, is owned by the owners of the preceding mine, but under the corporate name of "Societe Anonyme des mines d'or de Forest Hill Divide." Recently a tunnel has been constructed on this ground, designed to tap the channel in a distance of about one thousand two hundred feet. The intended plant is a duplicate of that at the other mine.

THE HERMAN MINE.

The Herman Mine, which lies one and one half miles southeast of the town of Iowa Hill, in Prospect Hill District, covers one hundred and sixty-two and one half acres, and was worked twenty years ago by the hydraulic method. The course of the channel here is northeast and southwest. This ground has been opened by a tunnel five hundred feet long, driven at a cost of $15 per foot through metamorphic slate.

The pay gravel is six feet deep, and of the kind called blue cement, similar to that of the Morning Star Mine, which is supposed to be on the same channel. No timbering has been needed here. The gravel is washed in sluices, but requires to be crushed in a mill, in the absence of which a considerable percentage of the gold is lost. Bowlders of diorite and quartz are found in abundance, and about three inches of water flow from the tunnel. The mine employs three men, at $3 per day. The tunnel is a crosscut in a westerly direction to the channel, the further developments consisting of four drifts of the following lengths, namely, seventy, one hundred, fifty-five, and forty feet.

Altitude	2,500 feet.
Length of tunnel	500 feet.
Cost of tunnel	$15 per foot.
Nature of pay gravel	Cement.
Nature of bedrock	Slate.
Depth of gravel (drifted)	6 feet.
Length of time worked	34 years.
Number of men worked	3
Wages	$3 per day.

The patent to the above property includes the Iowa claim, exploited by a tunnel three hundred feet in length, and in which two men are employed. This mine has to be timbered throughout. The gold is of coarser grain and finer quality than that found in the Herman claim. It is but little rounded by washing, much of it being still attached to quartz; neither is the gravel cemented. This is a different channel from that of the Herman Mine, being two hundred and fifty feet higher, and having a general east and west course. It is supposed to be identical with that of the Mayflower Mine.

THE MORNING STAR MINE.

This mine, situated a quarter of a mile from Iowa Hill, at an altitude of two thousand six hundred and fifty feet, embraces a tract of one hundred and sixty acres, through which an ancient gravel channel, having an average width of two hundred feet, strikes in a northwest direction. The bedrock is slate, the gravel cemented, and but few bowlders are found. The depth drifted is seven feet, the roof is hard cement, requiring only a few

posts and caps to support it; though, in other mines of the class, the worked-out spaces are filled, as far as may be, with the large cobbles from the gravel. The mine is opened by two thousand six hundred feet of tunnel, which cost $16 per foot (the high cost of the tunnel is due to the extreme hardness of the rock and to the use, until recently, of black powder). The mine has been worked more or less for thirty-four years, though only about one and a half years by the present company. It is ventilated by an air drift and shaft. The work done by this company since 1886 has been confined to development, an area of three thousand one hundred and forty-four square yards having been blocked in readiness for extraction.

This mine contains seventy-three thousand six hundred and twenty-nine cubic yards of gravel, from which one third may be deducted for bowlders and waste, leaving forty-nine thousand and sixty-six cubic yards for crushing. To this may be added one thousand five hundred and seventy-two cubic yards of bedrock, which pays to the depth of eighteen inches. The spruce and pine timber used costs 50 cents per set of two posts and one cap. The powder used is Safety Nitro, of which seventy-three pounds are consumed weekly. This mine is at present yielding seventeen carloads, one ton to a load, daily, with eight miners working at $2 5C per day, and eight mechanics, who receive $3 50 per day.

Between June, 1887, and May, 1888, the mine yielded two thousand three hundred and eighty-four loads, from which were extracted nine hundred and twenty-three and a half ounces of gold, worth $18 per ounce, giving $6 97 per load. Between November, 1886, and August, 1887, were taken out one thousand eight hundred and fifty-nine carloads, which yielded a profit of $8 per carload, about $11 gross per load. This richer gravel was taken from a deep part of the channel. The gravel being cemented to a hard pudding stone, cannot be washed in sluices, as is done with free gravel, but must be crushed in a mill.

At the mouth of the tunnel is located a steam mill with ten stamps of eight hundred and fifty pounds weight each, dropping from six to eight inches, from sixty-five to seventy times per minute, and crushing four and one half tons of cement per stamp per day of twenty-four hours, through round-punched screens with quarter-inch holes. The shoes and dies are of cast-iron. The feeding is done by hand. The apron is not plated, being simply a broad wooden sluice with transverse grooves about an inch wide and deep, which are nearly filled with quicksilver. About 90 per cent of the recovery is found in the mortar, the other 10 per cent in the grooves. The tailings contain about one half of one per cent of sulphurets, worth about $128 in gold and $8 in silver per ton. This material is not saved at present.

Altitude	2,650 feet.
Length of tunnel	2,600 feet.
Cost of tunnel	$16 per foot.
Nature of gravel	Cement.
Nature of bedrock	Slate.
Depth of gravel drifted	7 feet.
Pay	$6 97 per ton.
Length of time worked	34 years.
Number of men employed	16
Wages paid miners	$2 50 per day.
The gross monthly product, computed on average yield of gravel per carload	$3,000
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamps	7 to 8 inches.
Drops	65 to 70 per minute.
Screens	Round holes, ¼ inch in diameter.
Duty of stamp	4 to 5 tons in twenty-four hours.
Percentage of recovery saved in mortar	90

LIVE OAK DRIFT CLAIM.

This claim is located in Brushy Cañon District, two miles northwest from the town of Forest Hill, at an altitude of two thousand six hundred and eighty-six feet. The mine was first opened, to a slight extent, some time in the fifties, when a tunnel was run in, but on too high a level to strike the channel. A shaft was then sunk in the tunnel fifty-five feet to bedrock, and good gravel found; but water came in to a troublesome extent, and another tunnel was driven on a lower level; an uprise having been made, good gravel was struck; from this some thousands of dollars were extracted, when it gave out. After drifting to a trifling extent without finding any more rich gravel, the claim was abandoned till two years ago, when the present company took hold of it, and soon developed good pay. So far as opened, the course of the channel is north and south. There are three bedrock tunnels, respectively, nine hundred and eighty, one thousand, and six hundred feet long. The cost of driving is, at the present time, about $6 per foot, using blasting gelatine, No. 1, and Hercules, No. 1, powder, with hand drilling. The formation cut by the tunnel is slate, seamed with quartz. The gravel is cemented, and has all to be blasted. The stratum removed has an average thickness of about eight feet. The channel is from sixty to eighty feet wide, being over one hundred feet in places. From fifty-five to sixty-five carloads of gravel, one ton each, go from mine to mill daily. About twenty inches of water flows from the mine. The entire works underground are timbered with cedar, spruce, and pine, costing 1 cent per running foot. Large quartz bowlders, weighing from fifteen to twenty tons, are frequently met with. The mine employs forty-five men, at $2 50 and $3 per day for whites, $1 75 for Chinese.

The mill, which is located on the mine, has ten stamps, only five of which are running at present, owing to the insufficient supply of gravel. The stamps weigh eleven hundred pounds each; drop nine inches at the rate of one hundred drops per minute, crushing sixty tons of cement in twenty-four hours through a screen with round holes three sixteenths of an inch in diameter, and a surface of fifty-six inches by seventeen inches, using about eight inches of water. The shoes and dies are of steel from the East; cost per pound and consumption not given. The battery is fed by hand, the larger cobbles being picked out and thrown in a pile, where they are left to weather, after which they are washed. The apron is fifty-six inches wide and twelve feet long, with an inclination of six inches in the length; it is plated on two and a half feet next to the battery. There are four transverse grooves cut in the apron, which contain quicksilver. Following the apron is the Eureka rubber, from which the tailings flow through riffle sluices. Of the value saved 50 per cent is found in the battery, 10 per cent on the plate, and the remainder in the grooves, rubber, etc. The mill employs two men when running five stamps, at $3 per day. It is propelled by a Pelton wheel, with about sixty inches of water and seventy-four feet fall. The water comes from the Mayflower tunnel and is constant. The mine is ventilated by a No. 3 Noiseless blower.

Altitude	2,686 feet.
Length of tunnels	980, 1,000, and 600 feet.
Cost of tunneling	$6 per foot.
Nature of pay gravel	Cement.
Nature of bedrock	Slate.
Width of pay channel	80 feet.
Depth of gravel drifted	8 feet.
Length of time worked	2 years.
Number of men worked in mine	45
Number of men worked in mill	2

Wages paid whites	$2 50 to $3 per day.
Wages paid Chinese	$1 75 per day.
Wages paid in mill	$3 per day.
Number of stamps in operation	5
Weight of stamp	1,100 pounds.
Drop of stamp	9 inches.
Drops of stamp	100 per minute.
Duty of stamp	12 tons in twenty-four hours.
Kind of screen used	Round punched, $\frac{1}{16}$ of an inch.
Quantity of water used in battery	8 inches.
Quantity of water used for power	60 inches.*

IOWA HILL AND VICINITY.

While there are some promising quartz prospects about this place, none have been developed to any great extent. At Wisconsin Hill a few Chinese miners are cleaning bedrock in an old hydraulic mine. At Elizabethtown a small force of men are drifting in the Sumpter Mine. At Georgia Hill three men are working in a drift. At Grizzly Flat the Cameron Company has driven a tunnel in about three fourths of a mile, at the end of which a shaft was put down fifty feet without finding bottom. At Monona Flat, Watts Brothers are working eight men in a drift mine. They have a tunnel in over a half mile and are washing gravel with remunerative results.

BLUE WING GRAVEL MINE.

Situated on Road Hill, one half mile east of Iowa, formerly worked by J. B. Hobson as an hydraulic mine, is now being worked by him as a drift claim. The channel has a rich streak of gravel at the bottom about two hundred feet wide. The results of six hundred feet of prospecting drifts and gangways gave a yield of nearly $4,000, some pieces of gold obtained in drifting here weighing fourteen ounces. The gold, which is rough, and mixed with quartz, is of low grade, being only 750 fine. The gold from the top gravel was much purer, averaging 930 fine. This seems to be the general experience in the gravel.

RIVER BAR AND BED MINING.

At Horseshoe Bar, on the Middle Fork of the American River, half way between Forest Hill and Michigan Bluff, an operation is in progress similar to that at the Big Bend on Feather River, in Butte County. At the above bar the Middle Fork makes a loop, almost returning upon itself, and requiring only two hundred feet of tunnel to cut the dividing ridge.

The tunnel is thirty and one half feet wide, and twelve and one half feet high, with thirty-three feet fall; having capacity to take all the water of the river, even at its highest stage. No dam is required beyond a natural rocky barrier, which crosses the river bed immediately above the tunnel mouth. The river bed is dried for a distance of one and three quarters miles. Nothing has yet been done towards working the ground, beyond prospecting some of the bars, in which encouraging results were obtained. Although the work was begun in May, 1887, but little was accomplished prior to September, when more active measures were taken, and the job was practically done in three months, only hand drills being used, with Hercules, No. 1, powder. A company is now engaged working Mammoth Bar, on the same river, with an hydraulic elevator. About thirty men,

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*The miner's inch here is measured under four-inch pressure.

mostly Chinese, are here employed. The machine is operated with about three hundred inches of water, having four hundred feet fall.

PLUMAS COUNTY.

This county, which derives its name from the Feather River—the Rio de los Plumas, of the Spaniards—is bounded on the north by Shasta and Lassen; on the east by Lassen, on the south by Sierra and Butte, and on the west by Butte and Tehama Counties.

Plumas is one elevated and mountainous region, very little of it having an altitude of less than four thousand five hundred feet. Pilot Peak, on its southern border, reaches an elevation of more than six thousand feet, there being a number of other peaks in the Sierra further north nearly as high. These mountain ridges being eroded by many deep and precipitous cañons, impresses upon the whole country a wild and rugged aspect. Scattered throughout these mountains are many small but fertile and well watered valleys, in which some grain is raised and many cows are kept, dairying being here the principal industry. The county, with the exception of these open valleys, is everywhere heavily timbered with pine, spruce, cedar, and fir. Plumas is abundantly watered by the several forks of the Feather and the Yuba Rivers and their numerous tributaries. The winter climate here is rigorous and the snowfall deep at that season. The summers, however, are long and pleasant—warm without being excessively hot. The principal towns in Plumas are Quincy, the county seat, La Porte, Gibsonville, Jamison City, Indian Bar, Greenville, Taylorsville, and Big Meadows, the last three being in the agricultural districts. There are besides these a number of mining camps and hamlets containing from fifty to two hundred inhabitants each.

MINERAL WEALTH.

While this county, as already observed, possesses agricultural and grazing resources of no mean order, it is the mineral deposits within its borders that constitute its more immediate if not most lasting sources of wealth. From an early period placer mining has been largely engaged in here, though this branch of the business has suffered marked curtailment through the cessation of hydraulic operations. Drift and quartz mining, however, continue to be actively and successfully pursued. The principal centers of quartz mining being the Greenville, Dixie, and Jamison Creek Districts, in the vicinity of Indian, Mohawk, and Genesee Valleys. Drift and other placer operations are mostly confined to the central and southwestern parts of the county. Deposits of coal, copper-bearing veins, and beds of marble rank also among the mineral resources of Plumas.

GOLD-BEARING QUARTZ MINES.

PLUMAS EUREKA.

This mine, the property of an English company, and under the same general supervision as the Sierra Buttes, is situated in Quartz Mining District, half a mile west from the town of Johnsville, at an altitude of six thousand feet above sea level. The course of the vein is north and south; dips to the west at an angle of 75 degrees; average width, about six feet;

size of claim, two thousand one hundred feet on the line of the lode. Two ore shoots have been developed here, one one hundred and fifty and the other three hundred feet in length. New developments consist of a main tunnel six thousand feet in length, the vertical depth reached in the mine being about fifteen hundred feet. A shaft has been sunk one hundred and fifty feet below the tunnel level, the intention being to carry it to an entire depth of five hundred feet. Two twelve-inch lift pumps, operated by two hydraulic engines, the latter driven by thirty inches of water, miner's measurement, under seven hundred feet pressure, will afford sufficient power to sink the shaft to the above depth. The E. A. Rix compressor and Ingersoll drills are employed here. About three thousand pounds of Hercules powder are used per month, five thousand pounds of Firth's steel being used per annum. The cost of mining and delivery of ore at mill is $3 20 per ton; cost of running tunnel, including timber, $4 to $6 per foot; average distance made, about twenty feet per week. Pine timber is used, at a cost of 7 cents per running foot. Length of ditch built by the company, eight miles. Means of transporting ore to mill consist of three tramways, two fifteen hundred feet in length, and one eight hundred feet in length. Formation of walls—hanging, metamorphic slate, and the footwall syenite. The ore is free milling, and contains about 1¼ per cent of sulphurets, valued at $30 per ton. These are treated by the chlorination process, at the company's own works, at a cost of $10 per ton.

This mine is equipped with a sixty-stamp wet crushing mill, located on the west bank of Jamison Creek, at the foot of the mountain. This mill is provided with three Blake rock breakers, twelve Hendy feeders, two Patton pans, an iron barrel and batea for cleaning up, twenty Hendy concentrators, three Duncan concentrators, five Patton concentrators, plated sluices, and a special set of plates in a separate "plate house." The cost of milling is 48¾ cents per ton of ore. The mill employs twelve men, at an average of $3 03 per day. The ore yielded during six months ending June 30, 1888, an average of $7 92¼ per ton, this being above the general average for some years past. The mill tailings assayed $2 per ton for the six months. The loss of quicksilver per ton of ore is 0.27 ounces, nearly, or seventy-six and one half pounds to four thousand six hundred tons. The gold here varies in fineness; that from the batteries and first plates is about 700 fine, while that obtained by amalgamation of concentrates in pans, and from the lower plates, varies from 500 down to 018 in fineness. In the latter case it contains lead, extracted, no doubt, from lead sulphate and carbonate in the concentrates. The mill is driven by water, brought through four miles of flume from Jamison Creek, and under a pressure of two hundred and sixty feet, to a Knight wheel of eight feet diameter. This wheel is furnished with an adjustable nozzle, by which variations in the quantity of water obtainable may be accommodated. There is also a seventy-five-horse power steam engine, used when required to supplement or replace water power. The data given as to cost of working apply to the use of water power, that of steam being considerably more expensive. The stamps weigh eight hundred and fifty pounds each, drop eight and one half inches eighty times per minute, and crush 2.53 tons of ore per stamp in twenty-four hours. The shoes and dies are of steel, mostly English, and cost 8 cents per pound. The wear of shoes and dies is 1.06 pounds of steel per ton of ore crushed, and the cost, therefore, is 8½ cents, nearly. The screens are diagonal slot punched, No. 8, with a discharging surface to each battery of forty-five inches in length and six inches high. The foot-rail of the screen frame is from six to eight inches high, the former height being used with dies that are half worn, the latter with new dies, the object being to

keep the discharge at as nearly the same height above the dies as possible. Each mortar is furnished with a lip plate and a cast-iron trough, which receives the pulp and conducts it to a plated sluice fifteen inches wide and twenty feet long, in sections of fifteen and five feet, respectively, with a drop of several inches from the one to the other. All of these plates are silvered. Inside front plates are five inches wide.

The percentage of recovery of free gold in the batteries is 60, the remainder being found on the plates. The amalgam yields 20 per cent of its weight in gold when retorted. After passing the plates the pulp is distributed among the concentrators. The product of sixteen of the Hendy machines is reconcentrated by four more of the same, that of two Duncans by a third Duncan, and four of the Pattons in like manner supply a fifth. The waste from the reconcentration is again passed over silvered copper plates. The whole of the tailings, after leaving the concentrators, flow to the plate house, where the stream is divided between thirty-six plated sluices, each fifteen inches wide and five feet long, being diluted by an addition of clear water on each plate. The plate house yields about $300 worth of amalgam per month, rather more than paying the expense of keeping the plates in good condition by frequent resilvering, which is done economically in the company's works. After all this the tailings still contain a value of $2 per ton, and furnish profitable employment to about thirty arrastras. As the arrastra men subject the material to a slight concentration in broad ripple sluices, allowing the slimes to flow off before regrinding the coarser material, it seems probable that the value is mostly in the form of free gold inclosed in the particles of quartz, and consequently could not be recovered in the mill without finer crushing, which, however, would be disadvantageous in other ways. The sulphurets are treated by amalgamation in the Patton pans, yielding $25 39 per ton; the cost of treatment was not given.

Altitude at mill	5,645 feet.
Cost of mining	$3 41½ per ton.
Number of stamps	60
Weight of stamps	850 pounds each.
Drop of stamps	8½ inches.
Drops	80 per minute.
Duty of stamp	$2\frac{63}{100}$ tons crushed in twenty-four hours.
Kind of shoes and dies	Steel.
Cost of shoes and dies	8 cents per pound.
Wear of shoes and dies	$1\frac{6}{100}$ pounds per ton of ore crushed.
Cost of shoes and dies per ton of ore crushed	8½ cents.
Kind of screens	Diagonal slot, No. 8.
Width of lip plate	12 inches.
Width of plated sluice	15 inches.
Length of plated sluice to each battery	20 feet.
Kind and number of feeders	12 Hendy.
Kind and number of breakers	3 Blake.
Kind and number of concentrators	20 Hendy, 5 Patton, 3 Duncan.
Percentage of sulphurets	$1\frac{1}{10}$.
Yield of sulphurets by amalgamation	$25 39 per ton.
Cost of working sulphurets by amalgamation	Not given.
Cost of milling ore	48¾ cents per ton.
Loss of quicksilver per ton	$2\frac{7}{10}$ ounces.
Number of men in mill	12
Number of men in mine	173
Total number of men employed	200
Average wages paid in mine, with board	$50 per month.
Average wages paid in mill	$3 03.
Average wages paid outside work, with board	Mechanics, $60 per month; laborers, $40 per month.
Average yield of ore	$7 92½ per ton.
Average assay of tailings	$2 per ton.
Quantity of water used	Not given.
Pressure of water used for power	260 feet.
Cost of water	Free.
Kind of water wheel used	Knight.

GREEN MOUNTAIN MINE.

This mine is located in the Cherokee District, half a mile from the town of Crescent, at an altitude of three thousand eight hundred and fifty feet. Course of vein easterly and westerly, dipping west 70 degrees; average width twelve feet. Dimensions of claim, four thousand five hundred feet in length and six hundred feet in width. Two ore shoots have been developed of one hundred and fifty and three hundred feet in length. No. 6, or lower tunnel, six hundred feet long. Vertical depth reached in mine, one thousand one hundred feet from the surface. Hanging-wall is slate, and the foot is trap rock. Twenty-five miner's inches of water are running out of the tunnel. Burleigh's compressor and No. 3 Ingersoll drills are in use, and Vigorit powder is employed for blasting. Cost of mining per ton, 55 cents; cost per foot for running tunnel, $10. The tunnel is timbered its entire length—six thousand feet—with spruce timber; cost of timber, 5 cents per running foot. This property has been worked through a system of tunnels: No. 1 tunnel, two hundred and fifty feet; No. 2 tunnel, three hundred and fifty feet; No. 3 tunnel, five hundred feet; No. 4 tunnel, six hundred and fifty feet; No. 5 tunnel, about six thousand feet. The gross amount taken out of this mine has been $1,000,000 from the upper tunnels. The lower tunnel was run in for the purpose of developing the mine to a greater depth. About the time this tunnel was completed, the company being mostly eastern stockholders, and the stock unassessable, operations were suspended, pending an adjustment of the company affairs.

The sixty-stamp mill on this mine is run by water power; the Knight wheel is used under four hundred feet pressure, with ninety inches of water, which also drives the air compressor and two No. 3 Ingersoll drills. The water is obtained through one thousand feet of twelve-inch pipe, from the Round Valley reservoir, at a cost of $35 per day, the power sufficing to run all the machinery. In close proximity to the mine, the company owns one hundred and sixty acres of timber land, also four hundred acres of hay land purchased for depositing their tailings.

Number of stamps	60
Weight of stamps	750 pounds.
Drop of stamps	7 inches.
Drops of stamps	75 per minute.
Tons crushed	90 in twenty-four hours.
Shoes and dies	White metal.
Cost of shoes and dies, delivered	5 cents per pound.
Screen	Slot, No. 8.
Size of apron	4 by 6 feet.
Width of sluice	2 feet.
Length of sluice	16 feet.
Feeders used	12 Hendy Challenge.
Total number of men employed in mill	6
Outside work	4
Mine	55
Total number of men employed	65
Wages paid	$2 50 per day.

PLUMAS COUNTY MILL AND MINING COMPANY.

The property of this company is located in the Cherokee District, one and a half miles south of Greenville, at an altitude of four thousand two hundred feet above the sea. Course of the vein, northeast and southwest, dipping 80 degrees west; dimensions of claim, four thousand two hundred by six hundred feet. Four ore shoots, from eighty feet to three hundred feet in length, have been developed. Length of tunnel, two thousand one hundred feet; at the end of which a shaft has been raised to the surface,

four hundred feet. A shaft has also been sunk below the tunnel level three hundred and forty feet. At the bottom of this shaft, the vein, having been crosscut, shows a body of good average milling ore twenty feet wide, with virgin ground that will likely go to the surface, giving seven hundred and forty feet of reserves. The hanging-wall is granite, the footwall porphyritic slate. About five inches of water is now coming in below tunnel level, which is raised with an eight-inch lift pump to the tunnel level. The largest size of E. A. Rix air compressor is used, and No. 2 National drills. There are two of these drills in the mine. The cost per foot for running tunnel is $5; the cost of sinking shaft below the tunnel, $50 per foot. It is all timbered with fourteen-inch square timbers. Cost of round timber, 5 cents; square, 16 cents per running foot, timber being close by the mine. All the machinery is run by water power, furnished by the Round Valley reservoir. Fifty inches of water is used at a cost of $12 50 per day. The ore is dumped from the tunnel into the mill at a cost of 10 cents per ton. Ore, free milling, carrying about 1 per cent of sulphurets, valued at from $80 to $100 per ton.

Altitude	4,200 feet.
Number of stamps	24
Weight of stamps	850 pounds.
Drop of stamps	6 inches.
Drops per minute	80
Duty of stamps in twenty-four hours	36 tons.
Shoes and dies	White metal.
Cost of shoes and dies	5 cents per pound.
Screen	Slot No. 8.
Size of apron plate	4 by 6 feet.
Width of sluice	14 inches.
Length of sluices	20 feet.
Hendy's Challenge feeders	6
Value of sulphurets	$80 to $100 per ton.
Cost of mining ore	$1 50 per ton.
Cost of milling	$1 per ton.
Number of men employed in mine	25
Number of men employed in mill	5
Average wages paid in mine	$2 50
Average wages paid in mill	$2 50
Head of water used for power (Pelton wheel)	250 feet.

PACIFIC MINE.

This property is located in the Cherokee Mining District, four miles south from the town of Greenville, at an altitude of five thousand feet. Course of vein easterly and westerly, with a northerly dip of 80 degrees. Average width of pay strata, four feet. Size of claim, one thousand six hundred and seventy-five feet in length by six hundred feet wide. Length of ore shoot, four hundred and eighty feet; opened by tunnel five hundred feet long. Hanging and foot-walls, slate. Cost of mining per ton, $1; cost of running tunnel, per foot, $4. Tunnel all timbered; cost of timber, per running foot, 5 cents; plenty of timber on the ground. The ore from this mine is hauled to the Kettle Mill, located near Round Valley reservoir, at a cost of 30 cents per ton. This ore being free milling and soft, two and one half tons per stamp can be crushed in twenty-four hours. The Kettle (twenty-stamp) Mill is run by water furnished by the Round Valley reservoir.

Altitude	5,000 feet.
Number of stamps	20
Weight of stamps	850 pounds.
Drop of stamps	5 inches.
Drops	85 per minute.
Duty of stamp	2½ tons in twenty-four hours.

Shoes and dies	White iron.
Screen	Slot, No. 7
Width of apron plates	48 inches.
Width of sluice	16 inches.
Length of sluice	24 feet.
Cost of water for power	$12 50 per day.
Cost of mining	$1 per ton.
Cost of milling	$0 75 per ton.
Number of men in mine	6
Number of men in mill	3
Wages paid in mine	$2 50 per day.
Wages paid in mill	$2 50 per day.
Percentage of recovery saved in batteries	65
Percentage of recovery saved on plates	35

CRESCENT MINE.

This property is located in the Cherokee District, near the town of Crescent, at an elevation of three thousand seven hundred feet above the sea level. The vein, or ore channel, strikes easterly and westerly, and dips to the north at an angle of 70 degrees. The mine contains a network of veins: the Pet two feet, the Lee two and a half feet, the Ophir four feet, the Crescent four feet, and the Horseshoe fourteen feet in thickness, all in the same channel. Both walls of the vein are trap, and quite hard. This property is worked through a shaft two hundred and forty feet in depth. It takes an eight-inch lift and ten-inch plunger pump to handle the water. The hoist is run by steam power, and the sixteen stamp mill by water power, water owned by the company. The stated cost of mining and milling is $4 50 per ton; running the main drifts is $20 per foot; sinking shaft and timbering, $75 per foot; delivering ore to the mill, 8 cents per ton. The ore here is free milling; two thirds of the gold recovered is from the battery. The mill has a crushing capacity of about twenty-four tons per twenty-four hours.

Altitude	3,700 feet.
Number of stamps	16
Weight of stamp	900 pounds.
Drop of stamps	7 inches.
Drops of stamp	74 per minute.
Shoes and dies cost	4½ cents per pound.
Screens	Slot punched, No. 10.
Size of apron plate	52 inches.
Width of sluice	24 inches.
Total length of sluice	30 feet.

THE LITTLE JAMISON MINE.

This property is located in the Quartz Mining District, two miles south of Johnsville, at an altitude of five thousand feet above sea level. Size of claim, one thousand five hundred by six hundred feet. Course of vein, north and south, dipping easterly at an angle of 75 degrees. Average width, about ten feet. Opened by a tunnel following the vein into the mountain two hundred feet, showing a pay shoot of ore the whole distance. Vertical depth from surface reached in tunnel, sixty feet. Hanging-wall, syenite; foot-wall, metamorphic slate. The ore taken from the mine is worked by arrastras, and averages $30 per ton.

DRIFT MINES.

GLAZIER MINE.

This property is located in the Seneca Mining District, five miles east of Butte Valley Post Office, at an elevation of four thousand two hundred feet above the level of the sea. Size of claim, one hundred and thirty acres. Course of channel north and south, opened by tunnel. Upper tunnel, two hundred feet in length; lower, five hundred feet in length. Average cost per foot in running tunnel, $3. Formation passed through, slate. The pay gravel is cemented in spots, though the greater portion washes freely. The bedrock is soft slate. Depth of gravel drifted, three feet. The capacity of cars used in this mine is one ton each. Value of the gravel ranges from $1 to $20 per carload; one man mines on an average two carloads per day. This claim has been worked for three years. Width of the pay channel is fifty feet. Very little timbering is necessary; timber used is spruce, and grows on the company's ground. Six hundred and fifty feet of the channel has been worked out. When five hundred feet more of the upper end is worked out it will be necessary to open up the lower end of the channel by running a tunnel, eight hundred feet long, through which about four thousand feet of the lower end of the channel can be mined. Half a mile of flume takes water from the North Fork of Feather River, which is used for gravel washing. This channel is about sixty feet above the North Fork of Feather River.

Altitude	4,200 feet.
Course of lead	North and south.
Length of upper tunnel	200 feet.
Length of lower tunnel	500 feet.
Average cost running tunnel	$3 per foot.
Percentage of free washing gravel, averages	75
Depth of gravel drifted, averages	3 feet.
Pay per carload	From $1 to $20.

SUNNY SOUTH MINE.

This claim is located in Butte Valley District, on the North Fork of Feather River, at an elevation of four thousand three hundred feet above the sea. It comprises one hundred and sixty acres of ground. Course of channel, north and south; length of tunnel, eight hundred and fifty feet; formation, slate. The gravel has a depth of five feet, pays from 10 cents to $10 per carload, and is considerably cemented in some portions of the channel. From two to four carloads of one ton each are mined to the man. This claim has been worked at different periods since 1861. Width of pay channel, from two hundred to three hundred feet. The ground requires heavy timbering; cost of timber, 4 cents per foot. At present fourteen men are employed at $2 per day each, board included. The annual product of this mine has been as much as $60,000.

THE DUTCH HILL HYDRAULIC MINE.

This property is located in the Butte Valley Mining District, at an altitude of five thousand feet. Until 1874 it was worked as a drift claim and paid liberally, over $500,000 having been taken out of it. Since that time it has been operated as a hydraulic mine. The present owners have equipped it with a costly plant, some $300,000 having been expended on the same. For the purpose of bringing in water, thirty-five miles of ditch

and flume, supplemented by eight miles of twenty-two-inch iron pipe, have been constructed. On this ditch two thousand five hundred feet of tunneling, besides some side tunnels, have been required. The gravel banks washed here vary from fifty to seventy-five feet in height.

SAN BENITO COUNTY.

This county is named after the principal stream running through it; Benito being a title applied to a Benedictine friar or nun. This county is bounded on the north by Santa Clara, on the northeast by Merced and Fresno, and on the south, southwest, and west by Monterey County. Nearly one half of this county, including most of its arable land, lies in the San Benito Valley. This valley is skirted on the west by the Gabilan Mountains and on the east by the Coast Range, which separates it from the valley of the San Joaquin. There is some good timber on the Gabilan Mountains, but very little of any kind elsewhere in the county.

The San Benito River and its tributaries, together with the Pajaro on its northern boundary, take in the entire hydrographic system of the county. While San Benito possesses valuable mineral deposits, it is essentially an agricultural county; its products of wheat, wool, fruits, etc., being, for its area, notably large.

As far as present known, the mineral wealth of the county may be said to consist of quicksilver, coal, lime, petroleum, copper, antimony, chromite, and possibly more precious metals.

QUICKSILVER.

NEW IDRIA.

These mines are situated in the western end of Vallecitos Valley, upon the northeastern slope of the New Idria section of the Coast Range, in Secs. 32, 33, and 34, T. 17 S., R. 12 E., M. D. M. This district is situated on the southeastern borders of San Benito County, in the portion recently acquired from Fresno. As is well known, it ranks amongst the most famous quicksilver mines in the world. These mines were discovered about the year 1852 or 1853. Work was first commenced upon a deposit of chromic iron, at the top of the mountain, near the boundary line between Monterey and this part of San Benito County, then a portion of Fresno, under the impression that it was silver ore. Through assays made by the old padres of Monterey, cinnabar was discovered where New Idria now stands, and about 1854 or 1855 the New Idria Mine was located.

The lode is a large body of ore, in some places having been worked out to a width of two hundred feet. The vein has a general pitch toward the south of from 45 to 60 degrees. The foot-wall is a "silico-argillaceous" slate. In the lower workings there is a dark-colored clay, from a few inches to a foot or more in thickness, between it and the vein matter. The hanging-wall is a similar slate, but rather more compact in structure, often presenting a slickenside surface towards the vein, and being easily broken into glossy laminæ.

The vein matter varies in different parts of the workings. The better grade of ore has been found in the highest and western portion of the mountain. Most of the gangue is hard and siliceous, but at some times it is slaty or of a clayey nature, often containing much oxide of iron. The

ore richest in mineral is usually found toward the hanging-wall. Below the Day tunnel as far as has yet been explored, the vein becomes poorer, and the gangue, which is at first siliceous or slaty, changes to a sandy character. The New Idria mines are all in the northeastern slope of the mountain, which rises to the height of about one thousand five hundred feet above the reduction works, which are situated at its base; the summit of the mountain is between four thousand and five thousand feet above sea level. There are over three and one half miles of tunneling in the New Idria mines, not including the huge chambers that have been dug out in the heart of the mountain.

The highest workings are the oldest, and are at the ridge of the mountain. These consist of an incline running down upon the vein to the Sleeman tunnel. This tunnel, which is about nine hundred feet above the reduction works, runs south into the mountain for a distance of seven hundred feet, and was made in 1859. About two hundred feet lower down is the Myers tunnel, which was commenced in 1859, and finished in 1860. This penetrates the mountain to a distance of about one thousand feet. It is from this tunnel, and the Sleeman, that the highest grade of ore and the largest quantities have been taken.

The ore here also appears to be the most ferruginous, and at one point, where a small stream of water drips from the roof, there are to be seen stalactites of sulphate of iron. Upon the walls of all the upper workings fibrous gypsum forms in beautiful tufts like glossy moss. Some two hundred feet lower down, and about six hundred feet above the reduction works, is the Day tunnel. This was also started in 1859, and penetrated the mountain to a depth of one thousand five hundred feet. This tunnel has been prolonged outwardly by timber, in order to allow dumping facilities for the work above, that otherwise would have covered up the mouth of the Day tunnel. The dump of the Myers tunnel above has accumulated and slidden down upon the prolongation until there are over one hundred feet, at the commencement of the Day tunnel, running under this waste rock.

All these workings, from the top of the mountain to the Day tunnel, constitute the upper portion of the mine, and are connected with each other by various tunnels and upraises. About one hundred feet above the reduction works, and five hundred feet below the Day tunnel, is the Bell tunnel, or lower workings, about four thousand feet in length. This tunnel is timbered almost throughout its entire length with closely set timbers, there being over three thousand sets, with lagging both on the roof and sides. Each set requires a log twenty feet long and ten inches in diameter. The temperature in this tunnel is high, and the atmosphere damp and oppressive. Whether it is the effect of the heat and moisture, or some gaseous exhalation of the formation, is not known; but the timbers decay in an unusually short time, and two men are kept constantly employed in replacing the old ones by new. This rapid decay is more marked during sultry weather, when the draft in the tunnel is almost nil, and the atmosphere oppressive. Timbers immersed in water, or those which are kept constantly wet by seepage, do not seem to be so affected. Dry, seasoned wood lasts the longest. Timbers, after having stood in place for only thirty-six hours, have accumulated a mildew one inch in thickness.

The workings of the New Idria Quicksilver Company, at the San Carlos Peak, are for the present suspended. The furnaces are of the same style as those in use at the Idria, Austria, being square, about thirty feet in height, ten feet in width, and twelve feet in length. The furnace is fed at the top by means of a drop hopper, at the rate of one ton per hour, and

holding twenty-four tons when full. There are employed two men to each shift of twelve hours, on the furnace, and fifty men in and about the mines. The wood used is almost entirely manzanita and oak, which is furnished by outside Mexican labor, at $6 50 per cord, delivered at the furnace, one cord being consumed every twenty-four hours.

McLEOD MINING DISTRICT.

Both cinnabar and antimony occur in this district, which is situated fourteen miles northeast of Hollister. The minerals of this district, so far discovered, are antimony, quicksilver, and silver. The counties of San Benito, Merced, and Santa Clara, all corner within its borders. Much ore here has been and is still mined and reduced in this district, a further description of which will be found under the head of Merced County.

The mines in this district, which are within the borders of San Benito County, are situated upon the northern and western slopes of Antimony Mountain, which rises to the height of over three thousand feet above sea level, and nearly in the center of the McLeod Mining District.

The backbone and higher portions of Antimony Mountain are formed of diorite, syenite, and serpentine rocks, which penetrate a sandstone at its base, and argillaceous slates upon its slope, in which the principal mineral-bearing veins are chiefly located.

Upon the northern slope of Antimony Mountain are the Shriver and the Mineral Spring Mines, together with several smaller openings, some of which show extensive ledges of mineral-bearing rock. Further down upon the mountain are mines belonging to the same person. Work upon all these mines is, however, suspended in consequence of legal difficulties.

THE SHRIVER MINE.

This mine is situated in the southeast quarter of Sec. 31, T. 11 S., R. 7 E., M. D. M. There is an upper and a lower level. The lower level is a tunnel eight hundred and sixty-five feet long, from which there are two drifts for a distance of seventy-five and thirty feet, respectively, and a raise of one hundred and fifty feet to the upper level, which is a tunnel run in a southeasterly direction. The tunnel in the lower level is about five feet wide and timbered. It runs in a southeasterly direction for a distance of five hundred feet. The tunnel commences in a soft, argillaceous slate, which grows harder as the tunnel increases in length. At a distance of about five hundred and fifty feet there is a cutting to the northeast of about seventy-five feet, at the end of which is a small, irregular vein of light-colored clay, dipping to the southeast. At a distance of about five hundred feet from the mouth, the main tunnel bears off to the southeast; here the slate becomes more fissile, and the tunnel appears to be following a stringer of clay, which, about three hundred feet further on, leads to a stratum of hard, white clay about four feet in thickness. Above this clay is a vein about eighteen feet wide. This consists for about ten feet of a light-colored gray, slaty rock, for the most part stained with oxide of iron, and for about eight feet of fragments of hard, siliceous rock, cemented together with a white clay, similar to that below the vein. Above this, and between it and the hanging-wall, is a thin stratum, two or three inches thick, of particularly heavy, clayey matter, some of which showed sulphide of antimony. The vein pitches in a northeasterly direction at an angle of about 70 degrees.

The workings, after penetrating the compact argillaceous slate which forms the hanging-wall, pass through a fissile slate for about eight feet, which appears glazed and compressed along the lines of cleavage; beyond this is a compact slate, containing crystalline forms too irregular and soft for determination. Through this rock water drips, forming stalactites too brittle and fragile to bear removal without injury.

The water oozes through for several feet along the workings. On the west side of the vein the main tunnel rises to reach the upper level; here water was struck, issuing from a fissure partially filled with pebbles and running a stream of about forty gallons per minute. The connection between the upper and lower tunnels is now caved in. No ore is at present taken from these workings, although the drainage is being carefully maintained.

About a thousand feet in a southeasterly direction up the side of the mountains, and probably two hundred feet above the lower working, is the upper level. A tunnel has here been run into the side of the mountain for a distance of about three hundred feet. This tunnel is now caved in a short distance from the mouth; it is run in a soft argillaceous slate, with stringing veins running through it, here and there showing sulphide of antimony.

About two hundred feet above the upper level, and to the southeast of it, the vein upon which Shriver Mine is situated crops out. The vein is here sixteen feet wide. The gangue rock is somewhat harder than in the lower tunnel, which is probably due to exposure, and in many places it shows sulphide of antimony. The Shriver Mine has, therefore, a well defined vein from sixteen to eighteen feet wide, showing mineral in places, the exact value of which it is difficult to determine.

There are said to be reduction works at the Comstock Mine, and that quite a quantity of quicksilver was produced there. It is now, however, owned as railroad land, and converted into a stock range.

THE CHINA DIGGINGS

Have not been worked for several years; these are situated on Sections 20 and 21. On the first named section are two preëmptions and one homestead. The old Santa Cruz and Mariposa Mines are situated in the vicinity.

COAL.

Valuable discoveries of coal have been made in the New Idria section of the Coast Range, also in Priest Valley, sixty-five miles southeast of Hollister. A variety of coal resembling jet is also being worked near Elkhorn Station, and there are said to be good coal prospects on the Cienega Gabilan (swamp hawk) ranch. The coal-bearing formations at Emmett were worked as early as 1878. A variety of jet was then found which burned well, but on exposure to the air it cracked. About five hundred pounds were shipped to England, and there pronounced good jet, and that it would improve with depth.

The coal mine of J. J. Bart, which is situated about one thousand feet above the roadway, to the north of Emmett, is developed by an incline and a crosscut at the upper working, and a tunnel of about one hundred feet in length lower down. The incline commences on a small vein about three inches wide of black, lustrous lignite, much of which shows a woody structure. The working itself is in clay slate, of which both hanging and foot-walls are composed. The pitch of the vein is to the northwest, at an

angle of about 20 degrees. At one place, about half way down the main incline, the vein pinches out, but reappears shortly before reaching the crosscut, which is at a depth of about thirty feet. The main incline is continued for about sixty feet further, but is now caved. The crosscut is continued to the west as an incline, and follows the vein, which is from two to six inches in thickness. This crosscut is now filled with water to within a distance of thirty feet from the main incline. At the water's edge the vein is about six inches in diameter. Eighty feet below the mouth of the upper working is a tunnel, which has been started to connect with the incline and drain the upper workings of water. About one hundred feet have been already run in this tunnel, in a northerly direction. For the first fifty feet the formation was slate, followed by about twenty feet of conglomerate. Further on hard slate was passed through, upon the cleavage surface of which were small crystals of gypsum.

Coal has also been prospected for at several points in the New Idria section of the Coast Range. In the Vallecitos Mining District are several claims. On Panoche Creek, in Sec. 18, T. 15 S., R. 12 E., M. D. M., also upon the east side of the roadway, to the west of the well of the California Central Oil Company, some work has been done in the way of development, but the tunnel is caved near the mouth. There appear to be three coal veins, separated by strata of light-colored sandstone. These veins, the largest of which are over four feet thick, are composed of shale, interstratified with seams of coal. The coal is much disintegrated by exposure to the atmosphere.

On the Ashurst ranch in the Vallecitos are several coal prospects; probably a continuation of the coal measures which crop out on the east side of the road near the Central oil well. The formation is sandstone, occasionally interstratified with shale; in the upper portion of the hills is a fossiliferous sandstone containing pecten and other shells. The coal measures are exposed at two places on this ranch in the channels of the creek. At one point the vein is about eighteen inches wide, and dips a little to the east of south at an angle of about 45 degrees. It is composed of black fissile shale mixed with carbonaceous matter, and rests upon a stratum of clay about six inches thick showing carbonized plant remains; above the coal is a stratum of highly colored clay. In another portion of the same creek one layer and several smaller veins are exposed. The largest shows eighteen inches of coal, below which is a black fissile shale mixed with carbonaceous matter; above the coal is a dark-colored clay, but the lower portion of the shale is too much covered with wash from the bank above to admit of very close examination. In strike and dip it corresponds to the vein in the other part of the creek, and may be a continuation of the same. A few feet of work has been done on this vein and the coal appears to be of good quality. In the detritus covering the croppings of the vein were many specimens of fossilized wood, which had apparently come from the disintegrated sandstone in the hill above. It is stated that there are also croppings showing a vein of coal and shale about five feet wide upon Sec. 24, T. 17 S., R. 11 E., M. D. M. By crossing the New Idria section of the Coast Range, which here rises to the height of about four thousand feet above sea level, the watershed of the San Benito Creek is reached.

Upon the western slope of the mountains in Sec. 21, T. 17 S., R. 10 E., M. D. M., about three miles northeast of the creek, a large vein of coal is exposed. This vein was uncovered by a landslide which occurred during wet weather about three years ago. It is on the northern side of a ravine in the western slope of the New Idria section of the Coast Range.

The vein of about six feet in thickness, is exposed along its strike for a distance of one hundred feet, and dips to the north at an angle of about 40 degrees. The foot-wall and a portion of the vein is covered with debris from the hill above. The hanging-wall is a brownish shale, about eighteen inches thick, containing gypsum. Above this wall are about eight inches of sandstone stained with yellow ocherous impregnations, which is overlaid by a stratum of hard ferruginous sandstone a foot or more in thickness, and from that to the top of the bluff, probably two hundred feet, the formation is a gray friable sandstone interstratified with pebbles, sometimes increasing to the size of small bowlders, and strata of hard iron-stained sandstone a few inches in thickness. The coal appears to be of good quality, and resembles that in the Vallecitos. These croppings are partly upon land belonging to the Southern Pacific Railroad, and extend beyond into Government sections. There is no doubt that a careful investigation will discover similar formations in other spurs and hills upon the western slope of the same mountain. The coal near the New Idria Mines has already been described in the report of last year.

PETROLEUM.

The oil-bearing strata of San Benito County have as yet been prospected only in the Vallecitos Mining District, where a well has been bored by the California Central Oil Company. The road to this district from Panoche lies through Grizzly Cañon, a treeless, desolated section of country, where the erosive action of the winter's storms, cloudbursts, and atmospheric agencies are strikingly demonstrated in the precipitous banks of the dry watercourses, the gaping crevasses in the alluvial soil, and the grotesque shapes into which the sandstones and softer rocks are worn.

The works of the oil company are situated about eight miles from Panoche. Work was commenced here in 1886, and suspended during the following year. It is said that the company spent $20,000 upon their works, and that their well, which is sunk to a depth of four hundred feet, is now partially caved. The boring was through a light-colored sandstone, which became quite white towards the bottom, where a small quantity of oil was struck.

In the cañon to the north is a spring of dark-colored oil, and oil also seeps through the bed and bank of the creek at several places. In this district oil occurs at several other points, notably, upon the ranch of R. Ashurst, in Sec. 6, T. 17 S., R. 11 E., M. D. M.

LIME.

Lime is extensively manufactured by J. J. Bart, whose works are at Cienega, sixteen miles south of Hollister. Excellent limestone also occurs in the Twitchel Range, nine miles west of Hollister, where it has been burnt in pot kilns. The Twitchel kilns furnished the lime used in building the Hollister Court House. The Cienega lime works are situated in the Gabilan Mountains, in Sec. 30, T. 14 S., R. 6 E., M. D. M., and were started in December, 1885.

The geological formation of the neighborhood is entirely metamorphic, the rocks of the vicinity being principally granitoid together with altered limestone. The latter is a beautiful crystalline variety, which yields an excellent quality of lime, and is in great demand, especially for plastering and brick work. The strata of limestone in the quarry appears much disturbed, pitching southwest at an angle of 65 degrees upon the west side of

the quarry, and upon the north side to the northwest at an angle of 45 degrees. Before reaching the line a body of decomposed granitic rock was cut through for a few feet, and the clays and shales that separate the strata of limestone previous to the metamorphic action are strangely diversified, some being chalky, others slaty, while a few feet off they are granitic. The hill, at the foot of which the quarry is situated, rises to the height of over two thousand feet above sea level, being about seven hundred feet above the quarry. The limestone crops out at various places amongst the chemisal almost to the summit. Further to the northwest granitic rocks make their appearance in a ridge running north northeast by south southwest, and a short distance up the cañon from precipitous cliffs. Immediately at the point of contact, between the ridge of granitic rocks and the limestone, is a spring of water and an appearance of vein matter. One great peculiarity of the granitic rocks of this locality is their singular stratified appearance.

A few yards to the south of the quarry are the lime kilns, which are constructed very much upon the same principle as those described at Guadalupe, in Santa Clara County, but smaller. The kilns are upright, tapering towards the top, thirty-one feet high, and having a circumference at the level of the fireplaces of forty-two feet, with an inside diameter of four and one half feet at the same level. The charging floor is twenty-one feet above the firing floor, where two fireplaces heat the kiln; the point of discharge is ten feet lower down. The kilns are two in number, and have a capacity of about fifty barrels each twenty-four hours, each kiln consuming two and one half cords of wood. The lime can be delivered at Tres Pinos for $1 30 per barrel during fine weather. The wood used is pitch pine, costing $2 50 per cord delivered at the kiln, and the wages paid to the seven employés is from $50 to $60 per month each.

COPPER.

A copper mine, called the Antelope, has been opened about fourteen miles east of Emmett, upon the east side of the Panoche section of the Coast Range.

The Antelope Copper Mine was discovered in 1887, and is situated to the north of the stage road. The improvements consist of two incline shafts. The upper incline, some thirty-five feet deep, runs toward the west; the vein here is very irregular, but upon the whole, probably, conforms to the general dip of the hills, which is to the south southeast, the formation being much broken and disturbed, and is an arenaceous gangue impregnated with oxide and carbonate of copper and oxide of iron, running in streaks and occasionally forming nodules and pockets of very good ore. The foot-wall varies from a fissile to a compact slate of a somewhat sandy nature. The hanging-wall, or rather the stratum overlying the vein, for there is no clearly defined hanging-wall, is a similar rock, only rather more slaty in character. The lower tunnel, which is about forty feet further down the hill, is commenced in sandy clay shale. About forty or fifty feet in the formation is much disturbed, and between the disturbed rocks pockets of clay afford a passage to a small quantity of water. About fifty or sixty feet from the mouth of the tunnel there is a connection for air to the workings above. The dip of the formation is to the south. The tunnel is about one hundred feet long, and the vein has not yet been reached.

GOLD AND SILVER.

Auriferous placer workings have from time to time been found, and good float rock discovered in the hills to the north and northwest of Panoche; but the locality is too far from water to be available for placer mining during the greater portion of the year. Several years ago a party of Frenchmen commenced packing the dirt in sacks, on their shoulders, to the nearest creek, a distance of about two miles, but they could only make from 50 to 75 cents per day, and abandoned the enterprise. It is also claimed that a ledge of rock has been struck in the same district that assays high, both in gold and silver.

CHROMITE

Is found near New Idria, also in the vicinity of Emmett, and many other places, all being at present too far from railroad communication to make the deposits of commercial value.

There is also a large body of

HEMATITE

About two miles south of the Cienega lime kiln, and a deposit of gypsum is said to have been discovered upon Silver Creek, in the southern end of the county.

SAN BERNARDINO COUNTY.

This county takes its name from the old mission established within its borders, and the ruins of which are still to be seen at a point about ten miles southeast of the present town of San Bernardino. It is bounded on the north by Inyo, on the northeast by the State of Nevada, on the east by the Territory of Arizona, the Colorado River being the dividing line between them; on the south by San Diego, and on the west by Los Angeles and Kern Counties.

Nine tenths of this immense county consists of so called deserts, the unproductiveness of the land being due to the aridity of the climate, rather than the sterility of the soil. The surface of the county, which is generally level, has a low mean altitude, portions of it being depressed below sea level. The San Bernardino Mountains, a rugged chain, strike across the southwest angle of the county. The Providence Mountains, lying a hundred miles to the northeast, and having a north and south trend, are the next considerable range in the county, there being many short chains and isolated groups of mountains in other parts of it.

The county is without rivers and lakes, though numerous creeks, some of them of large size, flow from the San Bernardino Range. The so called Mojave River, a large stream where it issues from the mountains, grows less and less as it journeys out upon the desert, being at last wholly swallowed up by the arid sands.

What are put down on the maps of this whole southeastern portion of California as dry lakes, are simply shallow depressions, formerly the beds of lakes, but none of which now contain any water, except, perhaps, a little in excessively wet winters. There is no timber in this county suitable for making good lumber, except in the San Bernardino Mountains. Elsewhere the trees consist almost wholly of scrubby pines on the mountains, and a very sparse growth of the mesquite on the plains, with the yucca and a few palms on the Mojave Desert.

Over the greater part of this region bunch grass of several varieties grows abundantly, affording both winter and summer a vast amount of nutritious pasturage. The only obstacle to this being a superior stock country is the absence of water. This supplied, and it would, as a feeding ground, be surpassed by few other sections of the Pacific Coast.

San Bernardino Valley, occupying the southwestern angle of the county, is one of the most fruitful spots in California, the soil here being good, and there being ample facilities for irrigation.

MINES, MINERALS, AND MINING.

Mining in one form or another has been pursued in this county from an early day. At first the business consisted of placer operations, carried on in its southwestern part, chiefly in Bear and Holcomb Valleys, and along some of the creeks and gulches still further west. Later on some quartz mining was undertaken in this section of the county; which were not, however, attended with much success. After the discovery of the Comstock lode, the attention of the mining public having been strongly directed to silver, the whole northern part of San Bernardino was explored for that metal, and with such encouraging prospects that a number of mining districts were organized and many lodes taken up in that region of country. The districts so formed consisted of the State Range, Washington, Argus, Telescope, Armagosa, Potosi, and the El Dorado—the Ivanpah District, in the same region, having been formed in 1868, a little later. Owing to their remoteness, the cost of transportation, and otherwise adverse conditions, mining made so little headway in these districts that they came, in the course of a few years, to be about deserted. Since the construction of a railroad across the Mojave Desert, rendering the mines more accessible and greatly reducing the cost of transportation, mining operations have undergone some revival in these districts, with the prospect of becoming still more active in the early future.

Meantime, the Calico country, much more accessible and every way more advantageously situated, having been discovered and opened up, promises to plant in the very center of this county a prosperous and permanent silver mining industry.

CALICO.

This camp is situated about seven miles north of the town of Daggett, on the Atlantic and Pacific Railroad. Notwithstanding the want of fuel and timber, and the scarcity of water, the ease with which the ores here can be mined and milled insures a reduction of the cost of working in the near future, or whenever large and well equipped mills shall be erected, freight and wages reduced, and adjacent mines consolidated. At the present time ore is milled at a cost not exceeding $4 per ton. A considerable number of "chloriders" find profitable employment in the numerous mines within a radius of five miles from the town. These cannot afford to handle ore carrying much less than forty ounces to the ton, having usually to pay a tribute of one fifth, in addition to the expense of sacking, freighting, and milling; as a consequence large quantities of comparatively high grade ore are left in the mines or on the dumps, to be worked at some future time.

There are probably large ore deposits which, though they will not now pay, will ultimately be worked as quarries, when an hundred tons or more of rock can be broken out by a single blast, and, being transported by railways to water, will be reduced by the Boss continuous process, or by leach-

ing, in works capable of treating a thousand tons per day in an economical manner. The Boss process is used here in all but one of the mills, and no better field could probably be found for it, considering the quality of the ores. Moreover, the ores in many of the mines are so soft that it seems superfluous to build stamp batteries for their reduction, as the Huntington or any other kind of rollers would suffice for doing the work. This would also seem to be a good field for the Russel leaching process; in fact the ordinary leaching process has been used in some small establishments with success, treating the fine stuff, sifted by hand from old dumps, without roasting; 75 per cent of the assay value, about $16 per ton, having been extracted by this method.

The miners, especially the chloriders, constantly test the quality of their ore by means of a solution of sodium hyposulphite, which they call "hypo." The test is made as follows: A little of the powdered ore is placed in a test tube, and some "hypo" is added, and mixed by shaking. After a few minutes, some solution of calcium sulphide (here wrongly called "acid") is poured into the tube, and the richness of the ore is judged by the quantity of precipitate formed, and by the blackening of any undissolved horn silver in the residue. In some of the mines the ore contains a little carbonate of copper, and occasionally, perhaps, sulphate of lead is present. These substances dissolve in the "hypo," and, like the silver, blacken on addition of the sulphide. Some of the miners admit that this causes a difficulty by interfering with the estimation of the silver; while others claim to be able to distinguish the silver precipitate from that of the base metal. The lead may be prevented from dissolving, by adding carbonate of soda to the "hypo;" or it may be precipitated from the solution by an addition of carbonate of soda to that.* The precipitate should then be allowed to settle, and, when the liquid is clear, it should be poured into another test tube, before adding the sulphide, which will then throw down the silver. Copper, however, cannot be thus disposed of when occurring as carbonate in the ore. In case the copper gives trouble, the following method is recommended: Use ammonia, instead of "hypo;" either settle clear or filter, and add to the clear liquid dilute muriatic acid until the smell of ammonia can no longer be perceived. The dissolved silver will fall out as a white precipitate of chloride of silver, which will turn purple on exposure to light. Lead will not dissolve in the ammonia, and copper will not be precipitated by the muriatic acid. The tubes should be directed away from the face when adding the acid, on account of a possible spurting of the liquid. Common washing ammonia will answer; also the cheap, commercial muriatic acid. Warming the ammonia in the tubes will assist in dissolving the silver.

WATERLOO MINE.

This property, owned by the Oro Grande Company, is situated in the West Calico Mining District, two miles west of the town of Calico. Size of claim, one thousand nine hundred feet by six hundred feet. Course of vein, nearly east and west; dip, southerly about 60 degrees; width, from ten to eighty-five feet; length of the ore body, so far as known, six hundred feet.

The mine was first opened by an inclined shaft of three hundred and fifty feet, and later by a tunnel of six hundred and four feet, reaching the vein at a depth of one hundred and twenty-five feet vertically from the

*This reaction was discovered by C. H. Aaron and G. F. Beardsly, in 1882. It has been applied to the saving of lead in the Russel leaching process.

surface. No water has been met with. The hanging-wall is of a slaty character, remarkably smooth, and almost perfect for a length of several hundred feet. It is tinged a bright red color from a film of oxide of iron. The foot-wall, a soft, gray, siliceous rock, probably volcanic ash, is rough and irregular. The filling is of a diversified character, much broken, in angular fragments, and interspersed with heavy spar, the frequent, if not invariable, accompaniment of horn silver in the mines of this district.

The developments here comprise a "track level," five hundred and fifty feet; first level, six hundred and twenty-five feet; second level, five hundred and nine feet; third level, six hundred and ninety feet, and fourth level, one hundred and twenty feet, all in ore.

The developments made during the year are one hundred and twenty feet on the fourth level, five hundred feet on the third level, two hundred feet on the upper level, two hundred feet of crosscutting, and three winzes of eighty-five feet each. The whole of this work has so far been done through the shaft by means of a Baker horse power hoist, and by single hand drilling, using Giant and Safety Nitro powder. The tunnel has also been driven by hand drilling at the rate of from one and one half to four feet per day. The stopes only are timbered, square sets and stubs of pine from Flagstaff in Arizona being used; cost not given.

The plan adopted in taking out the ore is to stope alternate blocks, leaving intermediate blocks standing, thereby lessening the expense for timbers. The worked out stopes will hereafter be filled, and the other blocks be taken out. At present time not more than twenty-five feet of the width of the vein is being mined; the ore removed yielding, it is said, $25 per ton. Two men break out enough ore to keep the fifteen-stamp mill crushing about thirty tons per day. The ore is jaspery quartz, heavy spar, and a compact gray siliceous rock, containing, apparently, alumina, all, even the jasper, carrying horn silver. In the lower level some ore has been found which assays about one thousand ounces of silver to the ton. It contains also carbonate of lead, the silver being chiefly in the form of chloride.

This company has built six miles of wagon road, from the mine to Daggett, and has nearly completed five and one half miles of railroad, for the transportation of ore from the tunnel to the mills.

The ore is treated in the old mill, as it will be also in the new, by the Boss continuous amalgamation process, which at present costs not more than $4 50 per ton in the smaller mills of the district. Its treatment will be less expensive in the larger mill, which has sixty stamps, of eight hundred and fifty pounds each, with a drop of six and one half inches one hundred times per minute. Their estimated duty is three tons per stamp in twenty-four hours, through a thirty-mesh, brass wire screen, with a surface of forty-eight inches by sixteen inches, set with a slight inclination. The shoes and dies are of steel, costing 9 cents per pound. The feeders, of which there are twelve, are the latest improved form of the Hendy. The hopper of each feeder is suspended from above, and the ore passes therefrom through a chute to the revolving table—an arrangement that facilitates access to the adjusting screens, etc., as well as to the battery. The middle stamp operates the feeder, instead of the end stamp, as in the older style of machines.

Of pans, there are nine for grinding only, twenty-seven for amalgamating, and two for cleaning up. The settlers are twelve in number. The stamps, pans, and settlers are arranged in three parallel rows, the pans and settlers being at the end of the line of stamps, instead of in front as usual. A row contains four batteries of five stamps each, three grinding pans, nine amalgamating pans, and four settlers. The pulp is conveyed entirely

by iron pipes, no wooden trough being used. The arrangements for automatically supplying the pans with salt and bluestone in fixed quantities at regular intervals of a few minutes, and for feeding, drawing, straining, elevating, and redistributing the quicksilver, are seemingly perfect, as also those for "cutting out" any one pan or settler in the line, when requisite for repairing or other purpose.

The mill, which is illuminated throughout by incandescent electric lamps, is driven by a magnificent steam engine, the fuel being coal. One peculiarity of the mill is the use of grooved pulleys and ropes in place of heavy belting for the transmission of power. The mine employs twenty-six men at present, and will soon employ one hundred. The mill will require twenty-one men. The wages in mine and mill are $3 per day, except for timbermen, who receive $3 50 per day.

Length of shaft on incline	350 feet.
Vertical depth reached in mine	About 125 feet.
Length of ore shoot	600 feet.
Width of vein	10 to 85 feet.
Character of hanging-wall	Smooth slate.
Character of foot-wall	Rough, soft, siliceous.
Cost of mining, per ton	Not given.
Number of men employed in mine	26
Wages paid in mine	$3 per day.
Length of road built (wagon road)	6 miles.
Length of road built (railroad)	5½ miles.
Method of treating ore	Amalgamating by Boss process.
Number of stamps in new mill	60
Weight of stamps	850 pounds.
Drop of stamps	6½ inches.
Drops	100 per minute.
Duty per stamp	3 tons in twenty-four hours, estimated.
Kind of shoes and dies	Steel.
Cost of shoes and dies	9 cents per pound.
Kind of screens	No. 30, brass wire.
Kind of pans	Boss.
Number of pans for grinding	9
Number of pans for amalgamating	27
Number of pans for cleaning up	2
Number of settlers	12
Number and kind of feeders	12 Hendy.
Number of men required in mill	21
Number of stamps in old mill	15

The ore deposit in this mine has been spoken of as a vein merely for convenience, as it can hardly be called a vein in the proper sense of the term. The miners call it a vein, for no other reason apparently than that it has a considerable longitudinal extension, and is confined between two "walls," one of which is unusually perfect. But defining a vein to be a fissure, crevice, or space between two walls, the filling of which is more recent formation than either of the walls, or than the adjacent rock, it is extremely doubtful if this can be called a vein. It has rather the appearance of a tilted stratum, more or less brecciated, and impregnated with heavy spar, horn silver, etc., by infiltration from above and subsequently to the tilting. In this vein the hanging-wall is simply a plane of bedding, as is also the foot-wall.

The presence of striæ on the walls of other mines in this district has been adduced as evidence of their being regular veins; but then it is known that striæ are produced in strata in the same way as on the walls of veins; that is, by movement of the earth's crust, causing adjacent rock surfaces to slip on and abraid each other.

As the Waterloo appears to be a very good mine, the doubt as to its being a vein is of little practical importance except, perhaps, to those who

are engaged in seeking the extensions. The question as to the manner of impregnation, however, supposing it not to be a vein, may have an importance bearing on the probability of the pay continuing in depth.

BARBER'S MILL.

This establishment, owned by the Barber Mining and Milling Company, is situated in East Calico, where the company owns the following mining claims: the Voca, Silver Reef, Harmonial, Smelter, Ironclad, and Three Total Wrecks, all having a course a little south of east and north of west, and all supposed to be extensions of the Waterloo "vein." The most important of the claims are the Silver Reef and the Voca, which yield fifteen tons of ore per day, of the average value of forty ounces of silver per ton. The mill, besides working the ore from the company's mines, does the custom work of the camp, at a charge of $12 50 per ton, guaranteeing 80 per cent of the assay value, up to fifty ounces per ton, and 85 per cent if the ore contains more than fifty ounces per ton, the company buying the silver at a slight discount on New York quotations. The monthly output of bullion is about fifteen thousand ounces of silver, averaging 960 fine.

This mill is arranged for the "Boss Standard Continuous Process," commonly known simply as the "Boss Process," and contains a Blake rock breaker, and ten stamps of nine hundred pounds each, dropping seven inches one hundred and twelve times per minute, and crushing from two and one half to three tons of ore per stamp in twenty-four hours. The shoes and dies are of steel, and cost 12 cents per pound, one set lasting about three months on quartz, and double that time on porphyry. The screens are of brass wire, of twenty, twenty-four, or thirty-mesh, and having the clear dimensions of forty-six inches by ten inches; they are set with a slight inclination. The feeders, two in number, are the Hendy Challenge. There are six Boss pans, and two settlers. The wear of shoes and dies in the pans is two and two tenths pounds to the ton of ore treated, and the consumption of chemicals is thirty pounds of salt and three pounds of bluestone per ton, on an average. The quantity of water used in the pans is that which passes through the battery, being about one third of what would be used for the ordinary system of wet crushing and settling in tank. Ninety per cent of the assay value of the ore is recovered, and there has been no perceptible loss of quicksilver in three months' working.

The cost of working ore in this mill is $3 75 per ton. The mill is driven by a steam engine of fifty-horse power, with a daily consumption of three and one half tons of coal, at $12 per ton. Water is obtained by pumping from a well. The mill gives employment to six men at $4 per day, one being employed outside at $3 per day.

Number of stamps	10
Weight of stamps	900 pounds.
Drop of stamp	7 inches.
Drops, per minute	112
Duty per stamp in twenty-four hours	2½ to 3 tons.
Kind of shoes and dies	Steel.
Cost of shoes and dies	12 cents per pound.
Wear of shoes and dies (one set)	3 months on quartz.
Wear of shoes and dies (one set)	6 months on porphyry.
Kind of screen	Nos. 20, 24, and 30, brass wire.
Dimensions of screen	10 by 46 inches.
Kind and number of feeders	Hendy, 2
Kind and number of breakers	Blake, 1
Kind and number of pans	6 Boss.

Wear of shoes and dies	2$\frac{2}{10}$ pounds per ton of ore.
Consumption of chemicals in pans	3 pounds bluestone and 30 pounds of salt per ton of ore.
Number of settlers	2
Number of men employed in mill	6
Wages paid in mill	$4 per day.
Percentage of assay value of ore saved	90
Cost of treatment of ore	$3 75 per ton.
Power of steam engine in mill	50-horse power.
Consumption of coal per twenty-four hours	3½ tons.
Cost of coal	$12 per ton.

CUBA SILVER MINE.

This mine is located in the East Calico Mining District, three miles east of the town of Calico, is of a "pockety" character, with no regular vein. The claim is one thousand five hundred by six hundred feet, and is worked through two tunnels; one three hundred feet long, and one fifty feet long. The company has constructed five miles of wagon road for the transportation of ore to the mill and supplies to the mine. The ore is carried in wagons at a cost of $2 per ton; it consists of porphyry, heavy spar, and horn silver, consequently it is free milling. It is worked in the Hawley Mill by wet crushing and pan amalgamation, with Rae's electric attachment to the settlers. The mine employs eight men at $3 50 per day.

HAWLEY MILL.

This mill, which is situated on the Mojave River, eight miles east of Calico, is working free milling ores from the Cuba Mine. It is driven by a steam engine of sixty-horse power, burning three tons of coal per day, at $11 per ton, brought from Gallup, New Mexico. This mill has ten stamps of seven hundred pounds each, six and one half to eight inches drop, and from ninety to ninety-six drops per minute. Twenty-five tons of ore are crushed daily, through wire screens of twenty to thirty or forty meshes to the linear inch, and a little inclined. One battery has shoes and dies of cast-iron, the other of steel. No accurate records have been kept as to the wear of shoes and dies, but it is stated that iron lasts about three months, and steel "never wears out," owing to the softness of the rock crushed. The pulp from the batteries is received in settling tanks, in which the greater portion is deposited, to be shoveled out and charged in the pans as required.

The muddy overflow from the settling tanks passes to outside reservoirs, where the "slum" is deposited, and, when dry, is wheeled to an elevator, from which it falls into the settling tanks, and is worked with the sands. No rock breaker is used. The two feeders are of the Hendy style. There are two Horn pans, and two of another style, with wooden sides; also two settlers. The wear of the pan, shoes, and dies is "very small." The chemicals used with the ore are bluestone, salt, lye, and alum. The bluestone and salt are used in the pans, the lye and alum in the settlers, proportions not given. The water and tailings from the settlers are elevated by means of a "Chinese pump," in order to obtain the requisite fall. The loss of quicksilver is not known now; it was formerly three fourths of a pound per ton of ore worked. The results obtained are from 90 to 97 per cent of the assay value of the ore. The mill employs eleven men, at wages from $3 50 to $4 per day. The settlers are furnished with the Rae electric attachment, concerning the advantages of which there is here a difference of opinion. The machine cost $1,200, and makes six hundred revolutions per minute.

Altitude at mill	1,818 feet.
Number of stamps	10
Weight of stamps	700 pounds.
Drop of stamps	6½ to 8 inches.
Drops of stamp	90 to 96 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies in battery	Iron and steel.
Kind of screens	Wire, Nos. 20, 30, and 40.
Dimensions of screens	34 by 9 inches.
Kind and number of feeders	Hendy, 2
Kind and number of pans	Horn, 2, and common, 2
Number of settlers	2
Percentage of assay value saved	90 to 97
Loss of quicksilver per ton	¾ pound.
Kind and quantity of chemicals used	Bluestone, salt, lye, alum; quantities not given.
Number of men employed	11
Wages paid	$3 50 to $4 per day.
Horse power of steam engine	60
Kind and quantities of coal used per twenty-four hours	Gallup, New Mexico; 3 tons.
Cost of coal	$11 per ton.
Cost of water	Free, from Mojave River.

HUMBUG AND BISMARCK MINES.

These mines, situated close together, about one half mile east of the town of Calico, are little more than quarries in sandstone impregnated with horn silver, being in the nature of stock work. The surrounding country is slate, shale, quartz, porphyry, soft porphyry, sandstone, tufa, "mud," and gravel. The rocks here are much folded, tilted, crushed, mingled, and brecciated at various angles and in various directions. There is also present here chloritic porphyry, pudding stone, and conglomerate; further east are beds of borate of lime. Water is scarce and timber entirely wanting.

RUNOVER COMPANY'S MINES.

Although the property was not, in the month of May, open to inspection, the following information was obtained in regard to it: The property comprises a number of mines located in the district of East Calico. These mines consist of the Garfield, worked by a tunnel which reaches a vertical depth of three hundred and fifty feet from the surface. The ore is chloride of silver and "black metal" in porphyry, the country rock being also porphyry. No water in the mine and no timber used. The Thunderer is similar to the Garfield, which it adjoins. The two Occidentals, parallel with and adjoining the Thunderer on the west, are similar in character.

Adjoining the town of Calico, on the north are the Orientals, of which there are several, the Red Cloud, Mammoth, Wall Street, and Silver Monument. The country rock is porphyry; the ores are chiefly horn silver in heavy spar, with oxide of iron. These mines are worked by tunnels at a maximum depth of three hundred feet. The mines are dry and no timbering is required. Thirty men are employed at $3 per day for miners. The Silver Monument is in a small hill composed of a light gray or white, soft, siliceous rock, probably derived from volcanic ash. Although there is a tunnel in this mine, the hill is being quarried to the depth of sixty-five feet, and the entire mass is sent to the mill, which is situated about a mile from the town, in the northern edge of the valley, where water is obtained by pumping from a well. The mill has twenty stamps, and has been supplied with ore by the Red Cloud, Mammoth, Silver Monument, Garfield, and Occidental Mines.

RED JACKET AND SILVER KING MINES

Are situated close to the town of Calico, on the north side. These mines open into each other, being on the same vein, the course of which is here about northwest and southeast, dipping southwest at about 75 degrees. The vein dips with the strata on the flank of the hill and curves with its contour. In the Red Jacket there is the appearance of a foot-wall, smooth, striated, and continuous downward for several hundred feet. It extends laterally also several hundred feet, with, however, some breaks, and at one point a bifurcation. There is also, in places where it has been sought, an appearance of a hanging-wall, which at one point comes close to the foot-wall. The so called foot-wall is a light-colored porphyry, the filling is a soft porphyry, intersected in all directions with spar, which usually carries horn silver; the hanging-wall is also a soft porphyry, varying in thickness and backed by a seam of iron oxide, behind which is "mud" ore. Within the alleged vein also are masses of "muddy stuff," as the miners call it, containing fragments of porphyry, but very little silver. All of the filling carries more or less silver.

The impression left by a rather brief examination is that it is really a bed similar in its relation to the bounding rocks to a bed of coal; that is, a stratum which, with the supposed walls, was once horizontal, but has been tilted in the usual manner. Whether the metallic and sparry impregnation occurred before or after the tilting, is an open question. The slickensides and striæ are accounted for by almost inevitable sliding of the strata, the one on the other, during their upheaval. The Silver King, only seen in the sixth level, which served as an exit from the Red Jacket, is correspondingly the same as the latter. It has, however, been more extensively worked from the ninth level upward, though still containing a large quantity of low grade ore, which would not pay in former times, but will now be taken out. What may be found below the ninth level remains to be seen, some being of the opinion that the mine has touched bottom at the depth reached, about four hundred and fifty feet on the incline. These mines are quite dry, and, barring an occasional post, timber has only been required in a few of the crosscut tunnels.

VOCA MINE.

This, the first western extension of the Waterloo claim, has some tunnels and shafts which are only exploratory, the vein, or main ore body, as seen in the Waterloo, not having yet been found. From ten to twelve tons of ore are taken out daily from irregular streaks, which reach in places a width of five feet; but they have not been found continuous either in length or depth. This ore pays cost of exploration. An incline shaft has recently been commenced on the foot-wall formation of the Waterloo, which extends into this claim, and a streak or seam of black, clayey matter has been found which carries some silver, and may lead to a body of ore.

In this mine, contrary to the habit of the district, the ore so far found is mainly in a quartz gangue, much of it impregnated with micaceous iron. Heavy spar, the sign of silver in the other mines about Calico, is comparatively scarce here. Much of the quartz is of a jaspery character. The somewhat unsystematic manner in which this prospect has been worked has been justified by the ore found, but the property should be opened in one or two ways, either as has been commenced, by following the foot-wall country downward, and crosscutting at intervals, because in seeking an ore body either wall is an invaluable guide, is in fact the key to the situation;

or else going some distance toward the south, as the dip of the strata is southward, as is also that of the veins or ore body in the Waterloo, and sinking a vertical shaft, continuing it until either ore or the foot-wall country rock is reached. This is supposed to be the extension of the Waterloo vein; yet a tunnel which should have cut that vein between the points at which the two claims are worked, failed to do so.

On the Silver Reef, a leased portion of the Voca, the lessees have an inclined shaft down seventy-five feet, and some drifts in which good ore has been found, but no regular vein has been developed.

CLEVELAND AND MIDNIGHT MINE.

This property is situated in the low hills, four miles west of Daggett, three north of Fish-ponds, and five from Barstow. There are several openings on the vein, the deepest being an inclined shaft down fifty feet. The vein is nine feet wide, of heavy spar, galena, and in places iron oxide, with a good hanging-wall of porphyry, and a clay-slate foot-wall. The ore is said to have assayed twelve ounces of silver per ton and 15 per cent of lead.

M'SHANE MINE

"Is located in West Calico, three miles west of the Waterloo, and supposed to be on the same vein, claims one thousand five hundred feet by six hundred feet. The vein is from seven to eight feet wide, all in ore stated to assay from $24 to $800 per ton in silver, and can be traced seven hundred feet on the surface. The ore is horn silver in a gangue of heavy spar.

THE ALVORD MINE.

"A gold mine, situated fifteen miles south of Hawley's Mill, on the Mojave River, is a hill of low grade ore of a jaspery character. It has been worked about five years. The ore reduced at Camp Cady, in a five-stamp mill, yielded about $12 per ton. The country rock is syenite.

THE COMET MINE

"Is situated about one and one quarter miles east of Calico. Course of vein, northwest and southeast; dip, south about 80 degrees; width, six to eight feet. A tunnel taps the vein at a depth of seventy-five feet, but has not been carried through it. The mine, which is pockety, is worked by tributers. The ore is chloride of silver in spar, and has yielded during a year, as follows: First class, nine hundred and fifty ounces per ton; second class, one hundred and fifty to two hundred ounces per ton; third class, thirty-five ounces per ton, silver. The rich streaks are shallow, so far as known. There is also a spar vein yielding low assays in silver.

"There are other mines, more or less opened, within a few miles of the town of Calico, among which are the Inca, Union, Crown Point, Waleby, Bunker Hill, Josephine, Mountain, Walthal, Sioux, Young Waterman, Bedford, and Forrest.

BULLION.

"This mine is situated eight miles south of Seedlow Station, on the Atlantic and Pacific Railroad. The vein on the surface showed gray copper, with 62 per cent copper, a little silver, and traces of gold. At the depth of thirty-two feet a trace of copper, $5 50 to $32 in gold, and six

and one quarter ounces of silver per ton. The vein is fourteen feet wide, and the pay streak from eighteen to twenty inches. There is water three miles from the mine, but no wood in the vicinity.

"Stevens Mine is near Bagdad on the Atlantic and Pacific Railroad. Several carloads of ore from here have yielded seven hundred ounces of silver per ton. There is no mill on this mine.

"The Gold mines at Paradise, fourteen miles north of Calico, contain large deposits of ore which it is stated pay $10 per ton, but the properties are not opened to any extent.

"At Warm Springs District, fifteen miles east of Daggett, the several discoveries of gold and silver which have been made are considered valuable.

"Oro Grande District, called the East Camp, fifty miles south of Barstow, contains both gold and silver mines. A ten-stamp mill has been erected. One mine, the Blue Jacket, is now being worked (May, 1888). In the West Camp are mines of argentiferous galena, one of which has a shaft ninety feet deep, and drift fifty feet each way, all in ore. A letter was received, dated May nineteenth, stating that there are in the district three lime quarries, one granite quarry, and five lime kilns, all in operation, and employing two hundred men.

"In Chuckawolla District, twenty miles north of Mammoth Tank, on the Southern Pacific Railroad, two five-stamp mills are running on gold ore. There are also high grade ores of gold, silver, and copper in the district.

"In Ord Mountain, fourteen miles south of Daggett, are some copper mines. Bonanza King Mine, at Providence, thirty miles northward from Fenner, on the Atlantic and Pacific Railroad, has a five-stamp mill.

"In New York District, ten miles west of Providence, where there is plenty of water and pine timber, are located a number of mines, yielding both gold and silver; some of these have been worked to a depth of one hundred feet."

DAGGETT.

This town is situated on the Atlantic and Pacific Railroad, eighty miles north of the town of San Bernardino, at an elevation of two thousand and two feet. Temperature in July, 104 degrees Fahrenheit.

Hawley's Station, eight miles east of Daggett, stands on the north bank of the Mojave River, at the extreme eastern end of the Calico Range. It was established as an overland station in 1863, being on the old Mormon route from Salt Lake to San Bernardino. At this point the road forks, one branch going to Death Valley, the other to Fort Mojave.

Camp Cady is situated on the northern bank of the Mojave River, ten miles east of Daggett. The elevation is one thousand six hundred and forty feet, and the average temperature 85 degrees Fahrenheit. It was established as a Government fort in 1857, by Colonels Beal and Bishop. Having been subsequently abandoned, it was after a few years reëstablished in 1863 by Lieutenant Allen, in charge of a company of cavalry.

Coyote Hole is a spring situated seven miles north of Hawley's Station, on the west border of a dry alkali lake, containing about 6 per cent salt and 1 per cent borax. The water is unfit to drink.

Paradise Springs are situated on the first range of mountains north of the Calico Range, at a point twenty miles north of Daggett, elevation two thousand five hundred feet. Some of these springs are hot and others cold.

On the western slope of these mountains, and to the east of these springs, occurs a big ledge of quartzite, running in a northerly and southerly direction, and dipping to the east at an angle of 70 degrees. Located on this

ledge are two claims, known as the Vulture Mine No. 1, and the Vulture Mine No. 2. This ledge is from ten feet to twenty-five feet wide, and carries free gold, varying in value from $5 to $10 per ton. The developments here consist of a series of holes sunk on various portions of the ledge, to depths varying from ten to twenty feet. The formation consists of granite and porphyry dikes running parallel with the ledge, the vein being a contact between granite and porphyry.

The Garlic Springs are situated on the Resting Springs road, about thirty miles north of Daggett, and consist of seepage from a granite ridge. They stand on the western border of a dry lake at an elevation of two thousand feet. Temperature in May, 76 degrees Fahrenheit.

THE IVAWATCH MOUNTAIN MINING DISTRICT

Is situated in the Ivawatch Range, on the southwest edge of Death Valley, seventy miles northeast of Daggett. Elevation at mines, six thousand five hundred feet. This range strikes northwest and southeast, extending to the cross spur of the San Bernardino Mountains. Mineral in paying quantities has been found on both slopes, all along the range. The mines here are known as Nos. 1, 2, 3, 4, 5, 6, and 7. No. 7 is on the point of a hill east of the other claims and separated from them by a deep cañon. The ledge extends in a southeasterly and northwesterly direction, dipping to the west at an angle of 30 degrees. The hanging-wall of the ledge is composed of slate. Its average width in a shaft sunk sixty feet deep is eight inches. The ore is quartz, containing gold and silver. The formation is soft and the ore is easily extracted. The ledge is uncovered for a distance of four hundred feet. The assorted ore shipped from different points in this ledge yielded at the Daggett sampling works one hundred and twenty-five ounces silver per ton.

Four hundred feet east of No. 7 Mine occurs a strong quartz ledge running northeast and southwest. No. 3 Mine is situated on the northwest end of this ledge. The vein contains native silver, and averages, as per working tests, forty-four ounces per ton. In 1887 three tons of ore from this mine, shipped to Barber's Mill at Calico, yielded sixty-six ounces of silver per ton.

From No. 5 Mine, the southeast extension of No. 3, ore has been taken out and shipped to the smelting works at Reno, Nevada, for which receipts show a value of one hundred and twelve ounces silver per ton. In No. 6 Mine, the southeast extension of No. 5, the ledge runs along the northern slope of a high quartzite mountain. No. 3 Mine—Here at one point the ledge crops out on the side of a cliff at a distance of fifty feet above its base. From this cliff a great many slabs of float, in which native silver and specks of gold can be detected, have slipped down into the cañon. Under this cliff a crosscut has been run showing the ledge here to be twenty feet wide. Here a crosscut coming in from the south intersects the main ledge of No. 3.

The wood in this district is estimated at six thousand cords. Plenty of water can be had for all mining purposes. The line for the Utah Southern Railroad, as surveyed, runs eight miles east of this camp.

Cave Springs are situated thirty miles northwest of Garlic Springs, in a low gap in the Ivawatch Range, at an elevation of three thousand seven hundred feet above sea level. The water in these springs seeps from the bank on the east side of the road, and is so scarce that tanks have been constructed for storing it.

From the summit to Saratoga Springs, in Death Valley, a distance of thirteen miles, there is an average descent of three hundred and three feet per mile, three thousand nine hundred and thirty-nine feet between the two places.

Saratoga Springs are located on the north side of Death Valley, at the base of Tom Walters Mountains. The water flows on the surface for a distance of two hundred feet to where it forms a pond about one hundred feet square. The temperature of the water is usually from 70 to 80 degrees Fahrenheit. The extreme southern end of Death Valley, which extends south into San Bernardino County, is known as Soda Lake. Here the Mojave River sinks for the last time in its long course.

The Lydia Hetzel, Gravel, New Year, and Gambetta Mines are situated in Solo Mining District, thirty miles north of Ludow Station, at an elevation of three thousand five hundred feet. Temperature often reaches 100 degrees Fahrenheit in the shade in July. The ledges here extend in a northerly and southerly direction, and dip to the northwest at an angle of 60 degrees. The Gambetta Mine lies on the eastern slope of the hill, upon which all these mines are situated, and runs parallel with the Grant and Lydia Hetzel ledges, it being the southern extension of the New Year Mine. The Lydia Hetzel and Grant Mines lie on the western slope of the hill. The ore that crops out on the surface of the former carries from five to ten ounces of silver per ton, and 5 to 6 per cent of lead, and from a trace to $10 in gold. While croppings are exposed all over the hills, no ore is found in this dike carrying over six ounces per ton until the cap rock, varying from two to twenty feet in depth, has been penetrated. While so much ore is deposited throughout this dike, it seems probable that in depth all the ore will be confined to three separate ledges—the Gambetta and New Year in one ledge, the Grant and Lydia Hetzel in another, eight hundred feet of dike lying between them, and the Johnson ledge, one fourth of a mile further west, these being all parallel ledges.

This entire dike extends for five miles in length, its width being about two miles. From the highest point on the hill where the ledge crops out, to the lowest point of croppings, there is a difference of five hundred feet in altitude.

Campbell's Tunnel, running from the northwest, intersects the Lydia Hetzel ledge at a right angle, and cuts it at a depth of seventy feet below the surface. It shows the first streak of free milling ore on the hanging-wall side to be seven feet wide. This is called the "First West Ledge," and is separated from the next large body of croppings east by a small porphyry horse about ten feet in width.

After penetrating the cap rock, the formation, being softer, is easily worked. So far the ore has grown richer with the depth attained. At the highest point on the Gambetta ledge, a twelve-foot shaft has been sunk, all in free milling ore; forty feet further west a twelve-foot cut, run on the ledge, is also in free milling ore, the ledge here being five feet wide. A two hundred and fifty-foot tunnel, from the east side of the hill, is now being run to tap this ledge at a depth of two hundred feet below the surface.

Eight miles from the mine, with a gradual downgrade wagon road, there exists a good mill site, where water sufficient for all milling purposes is obtainable. Ten miles south from this mill site, from five thousand to six thousand cords of good wood can be procured and delivered at the mill for $6 per cord.

MORONGO MINE.

This mine is situated in Bear Valley Mining District, at an elevation of five thousand feet above the level of the sea; its dimensions are two thousand feet long by six hundred feet wide. The vein runs northeast and southwest, dips to the southeast at an angle of about 70 degrees, has an average width of about eight feet, and can be traced by the croppings the entire length of the claim. This mine has been opened and prospected by means of four shafts. Shaft No. 1, six feet by six feet, is situated about forty feet from the southeast end of the claim. It is fifty feet deep, all in ore containing chloride of silver and lead. The thickness of the vein at the bottom of the shaft was not ascertained, as no crosscutting has been done. Ten tons of the ore from this shaft, worked at the Daggett sampling works, yielded ninety ounces of silver per ton. Shaft No. 2, eight feet by eight feet, two hundred and ten feet northwest of Shaft No. 1, has been sunk to a depth of twenty feet. There is at the bottom of this shaft four feet of free milling ore and four feet of lead ore. The thickness of the ore body has not been determined, as there are no crosscuts.

Shaft No. 3, eight feet by eight feet, one hundred and fifty feet northwest of No. 2, has a depth of one hundred feet. This shaft is sunk outside of the ledge and a crosscut has been run from the bottom to the foot-wall, but not into the ore, as work on reaching this point was suspended.

Shaft No. 4, situated one hundred feet northwest of No. 3, has been put down thirty feet on the hanging-wall. The ore here looks well, but no crosscut having been made, the width of the vein remains undetermined. There is wood and water in great abundance. A good wagon road extends from Victor, on the California Southern Railroad, a distance of thirty five miles, to the mine. The ore is of such a nature that it can be easily extracted without much blasting.

TIMBER, LAND, WATER, AND RANCHES ON THE DESERT.

The timber belt known as the "Yellow Pine Range," trending southeast and northwest, extends from Providence Mountains on the south to Pahranagat Valley, in Nevada, on the north. The best timber portion of this mountain range enters Nevada from ten to twenty miles northeast of the California State line. Mr. J. Clark, owner of the only sawmill in this range, states that he has sawed and sold at the rate of $35 per thousand, one million feet of common lumber, of which there is about twice as much remaining. The rest of the timber here consists of scrubby pine. This belt of timber lies mostly on the east side of Charleston Peak, distant one hundred and fifty miles northeast from the town of Daggett. Snow lies on the north side of this peak the year round.

A majority of the creeks and rivers seen on the maps are quite as illusory as the lakes, nor are the springs there laid down always to be found. If, during an excessively wet season, some small streams are created in the mountains, they are apt to be short lived, drying up on the cessation of the rains or soon thereafter. On leaving the mountains these streams speedily disappear, being swallowed up by the almost always desiccated and porous soil.

By artesian boring, water can be obtained at many places on these deserts, but not everywhere, even though the wells be carried to great depths. In favorable localities water is usually obtained very near the surface, and sometimes in large quantities. Wherever procured in this manner it is soft and pure, though in some of the springs it is impregnated

with salt, soda, or other deleterious mineral to an extent that renders it unfit to drink.

MORANGO KING GOLD MINES.

This group of gold mines, consisting of the Morango King, Overly Scott, and Glasgow, is situated in Morango Mining District, on the eastern slope of the mountains, eighteen miles south of Old Woman's Springs, and forty-six miles north of Seven Palms Station, on the Southern Pacific Railroad, at an altitude of five thousand feet above the level of the sea. The ledge runs northeast and southwest for five hundred feet, then bends and runs north and south, and dips into the hill at an angle of 60 degrees. The ledge forms a sort of horseshoe curve around the hill on which it is situated. The geological formation consists of granite on the foot-wall, and slate on the hanging-wall. About the center of the Morango King ledge is a shaft sunk to a depth of one hundred and eighty feet. At one hundred feet below the surface are two drifts, each thirty feet in length, running on the ledge. Ore in bunches is met with, both in the drifts and shaft. This ledge crops out for about three hundred feet. Eighty feet northeast of this shaft another has been sunk to a depth of thirty feet on the ledge, which here averages four and one half feet in width. The ore from the above shafts is piled up on a dump containing from seventy-five to eighty tons, and is free milling, showing, occasionally, particles of free gold. Near the northern end of the Overly Scott Mine, there is sunk a fourteen-foot shaft, the ledge at this point being seven feet wide. Five miles west of these mines plenty of water and timber can be had for all mining purposes. Antelope Springs are situated one and one half miles east of the mines and four hundred feet below them. Water can be piped from these springs to a suitable mill site in the valley, eight hundred feet below the mines.

SAN BERNARDINO COUNTY.

By W. A. Goodyear, Assistant in the Field.

A portion of what concerns this county is taken from W. A. Goodyear's notes of trips made by him in 1872.

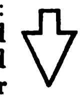
About half a mile southwest of Colton is Slover Mountain, a hill a quarter of a mile or so in diameter at its base, which rises some six hundred or seven hundred feet above the valley. It consists chiefly of limestone, which, however, varies greatly in character. Some of it is very fine-grained and pure white, and of a quality which, if it could be obtained in sound, unspotted blocks of uniform texture and sufficient size, would make a fine statuary marble. But much of it is very coarsely crystalline, often showing cleavage planes half an inch or more in diameter; yet even this coarse rock is much of it very compact, takes a fine polish, and makes a handsome marble. Some of it contains considerable graphite scattered through it in streaks and spots, and some of it contains micaceous iron. Some of it also contains a good deal of silica, and therefore will not make good lime.

Aragonite (wrongly called "onyx") also occurs here in veins and bunches, most delicately and beautifully striped and banded with various shades of yellow and brown, as some agates are. If (as is not improbable) it can be obtained in slabs of sufficient size, it will make extremely handsome mantel-pieces, table-tops, etc.

In the north end of the hill the rocks strike about north 70 degrees east, magnetic, and dip 45 degrees southeast. But in a large part of the hill the

metamorphism has gone far enough to greatly obscure, and in places entirely obliterate the stratification. A mill has been built here for sawing, cutting, and polishing the marble, which is being used to a considerable extent for building and ornamental purposes in San Bernardino and elsewhere. A good deal of lime is also being burned at various points around the foot of the hill. But a mile or two distant from here, on the opposite (or south) side of the Santa Ana River, all the hills are granite.

All the rocks in the neighborhood of the Arrowhead Springs (referred to in the Sixth Annual Report, Part I, page 70) are granite and gneiss, and the waters of the springs contain considerable sulphur. The "Arrowhead" itself is a great spot on the mountain slope, just back of and above the springs, which is comparatively free from brush, and is shaped thus:



Its extreme length is said to be one thousand three hundred and twenty feet, and its width across the shoulders three hundred and fifty feet. It is a conspicuous object from all points in the valley for a distance of many miles to the south. It is said that the early Mormon settlers used to call it the "Arrowhead of the Lord."

There are many artesian wells in the San Bernardino Valley, and amongst them the largest one which the writer has yet seen in the State is located some two or three miles east, or a little south of east of the City of San Bernardino. It is in low ground on the north side of, and only about one hundred yards distant from the Santa Ana River. It is two hundred and twenty feet deep, and when uncapped flows a solid jet of water seven inches in diameter and twenty inches high above the top of the pipe, which rises two or three feet above the ground.

About three quarters of a mile southeast of Casa Blanca Station, on the Riverside division of the California Central Railroad, a rather dark-colored granite is being quarried to some extent for building purposes. There has been from time to time within the last year or two considerable talk in the newspapers concerning a reported valuable discovery of coal near South Riverside. This locality was visited on May nineteenth. It is in the northeastern foothills of the Santa Ana range of mountains, some three or four miles south 25 degrees west, magnetic, from South Riverside. Here a bed of coal strikes about north 70 degrees west, magnetic, and at the surface dips 65 degrees or 70 degrees northeast. A tunnel runs in about sixty feet, and from the tunnel a shaft has been sunk about one hundred and seventy feet deep. The coal, so far, has been very irregular in thickness as well as quality. At the surface is a very impure streak from one to two feet thick. About fifty feet down it widened out to four feet of tolerably clean but soft coal. But below this again it pinched out to only three or four inches, and was very irregular in its dip. At the bottom of the shaft it was dipping about 50 degrees *southwest*. The locality is some two hundred or two hundred and fifty feet above the valley. The rocks here are sandstones and clay shales, quite soft, and containing much gypsum, and a good deal broken up.

About half a mile southeast of here is another locality where prospecting was being done for coal. There is here a great amount of carbonaceous matter irregularly scattered through the rocks, which strike northwesterly and stand nearly vertical. But it is nevertheless unfortunately the fact that what has hitherto been discovered is not good, and the present outlook for anything better is very poor.

Close by the latter locality there is a deposit of so called "Mineral Paint," *i. e.*, a sort of compact variety of red ochre, which, on being placed in water, very quickly crumbles and falls into small fragments in a manner

suggestive, by its rapidity, of the way in which well-burned quicklime slacks.

Traveling about three and one half miles southeasterly from South Riverside, up the Temescal Valley, and then about three and one half miles northeasterly among the hills, we reach the famous "Temescal Tin Mines," on the western part of the Mexican Grant known as "El Sobrante de San Jacinto," and where the aneroid barometer read one thousand two hundred and eighty feet. The country here is granite. The tin occurs associated with much manganese, some arsenic, iron, and other substances, in veins which traverse the granite in a northeasterly and southwesterly direction. The vein on which most work has been done strikes about north 30 degrees east, magnetic, and dips some 60 degrees northwest. E. N. Robinson, in charge of the property, states that there are over fifty such veins, with nearly parallel strike and dip, within a region here about seven miles long in a northwest and southeast direction, and some four miles wide. The existence of tin at this locality has been known for twenty-five or thirty years. But no reduction works were ever erected, and sufficient work has never yet been done underground to prove whether there are any mines here that will pay. If they are ever successfully worked, it will be necessary to crush and concentrate all the ore before smelting; and it is some distance from the mines to any point where a sufficient supply of water could be obtained.

At a point about two miles south 60 degrees east, magnetic, from South Riverside, a quarry of hard, dark-colored porphyry has recently been opened up, to furnish rock for macadamizing streets in Los Angeles and elsewhere. The rock is a good material for the purpose, and a belt of it at least a mile or two in width stretches for a considerable distance in a northwest and southeast direction, along the western side of the Rancho El Sobrante de San Jacinto, and extends east to within about one mile of the tin mines, where the granite comes in. About a quarter of a mile below the quarry, on the left bank of Temescal Creek, extensive crushing works, unfinished at the time of my visit, were being erected, and two seventeen-inch by ten-inch jaw rock breakers (large and heavy machines) were already in place. These two crushers alone ought to turn out a product of not less than two hundred tons of rock crushed to the proper size for macadamizing purposes in each day of ten hours run.

At the Temescal Post Office, about eleven miles southeast of South Riverside, there were (May 20, 1888) two artesian wells three hundred feet deep, with ten-inch pipes. One of them was capped; but the other one, whose pipe rose about five feet above the ground, was flowing a stream of good water one and one half inches high over the top of the pipe.

About a mile above the Post Office there is, in a "mesa" of granitic debris, a deposit of clay which has been thought to be valuable, but which does not look very good.

On the southwest side of the Temescal Cañon, about a mile below the Post Office, are the "Temescal Hot Springs," where there is a bath house. These springs are of sulphur water, with a temperature of 95 degrees to 100 degrees Fahrenheit.

On the second day of June, 1872, the present writer climbed the highest point of Mount San Bernardino, commonly called "Old Grayback," and got some barometric observations on the summit, which constitute, so far as he knows, the first measurement ever made of the height of this mountain. The following quotation is made from an article subsequently written by him for the "San Francisco Evening Bulletin," and published by that paper in its issue of July 3, 1872:

"I ascended the mountain, in company with Mark Thomas, of San Bernardino, on the second of June, 1872. The instrument used at the summit of the mountain was a Green's mercurial barometer of the best kind, and in perfect order.

"Simultaneous observations were taken at the town of San Bernardino, with a small aneroid barometer, also of Green's make. But, owing partly to the inherent defects of aneroid barometers, and partly to the fact that, through an oversight, the temperature of the air at the town of San Bernardino was not observed, I have considered the observations of the aneroid as untrustworthy, and have deemed it better to compare the observations at the summit of the mountain directly with those of J. B. Wells, United States Signal Service Observer at San Diego, and also with those of Thomas Tennent, at San Francisco, on the same day. The result is a discrepancy of about a hundred feet in the altitude, as determined from the two localities. The comparison with San Diego gives for the height of the mountain about eleven thousand six hundred and fifty feet, and the comparison with San Francisco about eleven thousand five hundred and fifty feet above the sea.

"Of these two results, the one obtained from San Diego is probably somewhat the more trustworthy, as in this case the distance between the two stations is only about one hundred miles, while from San Francisco to the mountain it is something over four hundred in an air line.

"From the above facts I conclude that we may safely assume eleven thousand six hundred feet as a very fair approximation to the actual height of the mountain, with a probability, however, that whenever it may be more accurately determined, it will be found to slightly exceed rather than to fall short of this figure.

"The peak which forms the initial point of the United States land surveys in this part of the State is not the highest part of the mountain. The highest summit, the one which I ascended, is the one known at San Bernardino as the "Grayback." Its crest forms a ridge three or four miles long in an easterly and westerly direction, with the highest point at the eastern end, and some seven or eight miles distant, in a direction a little south of east from the initial point of the land surveys.

"The San Jacinto Peak, immediately south of the San Gorgonio Pass, lacks but a few hundred feet of being as high as Mount San Bernardino itself. By the aid of a hand spirit level which I had with me, I estimated that the "Grayback" was some five hundred or six hundred feet higher than the San Jacinto Peak, one thousand or one thousand two hundred feet higher than the initial point of the land surveys, and one thousand five hundred to two thousand feet higher than San Antonio Peak, the highest peak of the San Gabriel Range, to the north of Cucamongo, and west of the Cajon Pass. And it may be noted that, assuming the correct altitude of the "Grayback" to be eleven thousand six hundred feet, the last of the above estimates agrees well enough with Professor George Davidson's determination of the height of the San Antonio Peak, which makes it nine thousand nine hundred and thirty-one feet ('field computation') above the sea."

Writing now in 1888, there is nothing in the above quotation which needs correction.

On the southern flank of Mount San Bernardino, a belt of unaltered sandstone, shales, and pebbly conglomerates some four or five miles in width, stretches a long distance in an easterly and westerly direction and rises to heights of four thousand to five thousand feet above the sea against the sides of the range. These rocks have been greatly disturbed, and in the cañon of Mill Creek exhibit a great synclinal fold. The rocks near the

mouth of the cañon dip northerly at tolerably high angles. A little further north, for a certain distance they lie nearly horizontal; while still farther north and higher up the cañon, near where it makes a great bend a little below the "Potato Ranch," they dip at high angles to the south. Above these unaltered rocks the greater portion of the mountain is granite, which, however, varies largely in texture and composition. Some of it is porphyritic with very large crystals of feldspar, and much of it is more or less gneissoid in structure. But besides the granite there are also considerable quantities of highly metamorphic rocks in the range, as is proven by the bowlders strewn along the bed of Mill Creek, many of which are gneiss, some of micaschist, some of dark colored hornblendic slates, and some of a coarse-grained, white and handsome marble. Some diallage or hypersthene rock was seen high up near the summit of the mountain. Mr. Mark Thomas states that on the north side of the San Bernardino Range, the quantity of unaltered sandstones, etc., is enormous, and that they reach up as far as Holcomb Valley. No fossils were found in these unaltered rocks. But they cannot probably be older than the Cretaceous period, and their presence here so high up on the range proves that the great mass of the range itself was uplifted from beneath the ocean subsequent to their deposition.

The quantity of the metamorphic stratified rocks in this range, though absolutely quite large, is nevertheless very small in comparison with that of the granite and granitoid rocks; and the same statement holds good for the whole San Gabriel Range, from the Cajon Pass west almost to the Los Angeles River, that range also being mainly granite.

And, by the way, I wish here to earnestly protest, in the name of common sense, against any such changing of the names of high mountain peaks and ranges as has somehow or other within the last few years crept into fashion in this part of Southern California.

The old name of the whole range of mountains from the Cajon Pass west to the Los Angeles River, was the "San Gabriel Range;" the name being taken from that of the old mission in the valley below—and that name is as good as any other—and its highest peak, only a few miles west of the Cajon Pass, is "San Antonio Peak." But, the vulgar name of "Old Baldy" has been applied to San Antonio Peak by somebody who perhaps fancied it poetical; and the whole San Gabriel Range has been dubbed "Sierra Madre" by somebody who either did not well understand Spanish, or else was in the careless habit (I care not, even if it were, as somebody has asserted, some of the old mission padres themselves) of calling every high mountain range a "Sierra Madre." There is no such thing as a "Sierra Madre" anywhere in this part of the country; and that name, together with "Old Baldy," ought to go where "Fisherman's Peak"—an unjust and ridiculous misnomer for Mount Whitney—has already gone, viz., into oblivion.

The rocks of the Calico Mining District, so far as the writer has seen them, *i. e.*, for a radius of at least a mile around the town of Calico, are exclusively volcanic in origin. They consist partly of massive eruptions and partly of heavy accumulations of detrital materials in the shape of clays, sandstones, breccias, and conglomerates, whose constituent particles were almost all derived from the disintegration of earlier volcanic eruptions, though they do occasionally contain fragments of granite, etc., torn from the more deeply underlying rocks by the earliest eruptions and afterwards scattered about amongst the volcanic debris.

"King Hill" (on the southern flank of which some of the most important mines are located) is very largely a massive eruption, and that eruption must have been far subsequent in date to the accumulation of the

detrital materials which surround it and which it uplifted. The same period of massive eruption which produced King Hill as one of its small spurs probably also involved more than one hundred square miles of country around to the north of here—possibly several hundred.

It is certain, however, that since that time great portions not only of King Hill itself, but also of the detrital rocks which flank and surround it, have been greatly altered and metamorphosed by the solfataric action connected with the formation of the mines. Few, if any, veins were formed, and certainly none of a character that has been sometimes represented. There is no regularity whatever in the stratification of the detrital rocks here. On the contrary, they are folded and crumpled like masses of paper in every direction—a common result of volcanic uplifts.

Near the Runover Mill, at the very southern foot of the hills at the edge of the plain, there is a massive volcanic rock which Mr. W. Lindgren has called "hornblende-andesite," and which he thinks is "later than the sandstones." In this he may be right, and this rock may belong to the same period of massive eruptions as King Hill itself. But the evidence on this point is scarce. To the north of this the detrital rocks extend irregularly up the southern flank of King Hill, almost as far as the outcrop of the Silver King Mine; and still further north the same formations again make their appearance about the Bismarck and the Humbug Mines north of King Hill, where some of them occupy a nearly horizontal position.

In at least two of the most productive mines of this district, viz., the Silver King and the Oriental, No. 2, there is *no vein at all*. The rocks, both massive and detrital, have simply been shattered and cracked through and through in all directions. But no "crack" has in these mines ever opened into a fissure in which a vein could form; nor has any definite mineralized belt ever been formed in this region with limits of any sort, such that any United States Court would hold it to be a "vein," even within the broad limits of legal signification which have been allowed to the word "vein" in decisions rendered. As already stated, the cracks run in every direction, and they are very numerous; and the whole body of rock, both massive and detrital, has been more or less permeated, and very irregularly impregnated in all directions with sulphate of baryta, chloride of silver, and some other minerals.

The talk about a "vein" with a "foot" and "hanging" wall in the Silver King and Oriental No. 2 Mines proceeds from the following facts:—Some of the cracks above mentioned are more extensive and can be traced for longer distances than others. And it so happens that, in the Silver King ground, one of these cracks (the miscalled "foot-wall") has been followed in the mining works for a distance of one thousand feet, or somewhat more, with a general strike of about north 65 degrees to 75 degrees west, magnetic, and a dip of 70 degrees to 85 degrees to the south. But this same crack forks and splits at numerous points, in directions of both strike and dip; and along the surface of the ground, on what is called the "Silver King Outcrop," there were at many points several different cracks, or seams, any one of which could with equal justice and reason have been chosen by parties interested as the main one, and *called* the "foot-wall," or anything else. It also happens that in the Oriental No. 2 claim, which lies next southwest of and adjoining the Silver King (the boundary line between the claims running north 63 degrees west, magnetic), there is another crack, which has been followed for a considerable distance in a general (though varying) northwesterly direction, and near which considerable bodies of rich ore have been found. And this seam has been dubbed the "hanging-

wall," the distance between the two varying all the way from twenty feet or less, to one hundred feet and more, and all the country between these cracks has been called "the vein." But there is also another extensive crack in the Oriental No. 2, which might just as well be called a "hanging-wall"—and there are many other cracks. In one place in the Oriental No. 2, a piece of very rich ground was stoped out between two cracks which for a distance of forty feet or so were nearly parallel and nearly vertical, and only some three or four feet apart, leaving beautifully smooth and regular walls for that distance. This place, at first glance, looked wonderfully like a vein; but it was not—for neither crack had opened out to any width. Each had its own two surfaces of fracture independent of the other, and the material stoped out between them, rich as it was, was like all the rest of the ore from these mines—nothing but the partly decomposed country rock, which happened here to be more highly impregnated with chloride of silver than it was in some other places.

It is indeed true that, as a general rule, most of the rich ore bodies here have been found in the immediate vicinity of the most extensive cracks; and it is also true that frequently the ore-bodies accompanying any given crack have been found to lie for some distance chiefly on the same side of that crack, though this last rule by no means always holds. And this state of things is exactly what might have been expected in a formation of this character. It is simply a mass of volcanic rocks of various characters and ages, which have been greatly altered, decomposed, shattered in all directions, and irregularly impregnated with silver ores and other minerals. There is, probably, more or less silver in almost every ton of rock in the neighborhood of Calico, but how much of it will pay to mine and work can only be determined by actual experiment.

The name of "liparite" has been applied to the rock which forms the mass of King Hill, in which these mines are, and correctly so according to the nomenclature of Baron von Richthofen in his "Natural System of Volcanic Rocks," for it is a "porphyritic rhyolite."

Many of the cracks here show well marked "slickensides" on both walls; but there is little evidence of any "King System (or any other "system," for that matter) of Faults" here. There is absolutely no evidence whatever of any fault or throw approaching five hundred feet in magnitude since these mountains were uplifted; and there *has* been a *great deal of erosion* since then.

Some other facts concerning this district are given in the communication read by Waldemar Lindgren, Esq., of the United States Geological Survey, before the American Institute of Mining Engineers in February, 1887. But some of the statements therein contained are not correct.

The following information and statistics concerning some of the Calico mines are kindly furnished by Mr. J. R. Scupham, Mining Engineer:

The Oriental-Garfield Mines, Calico District, San Bernardino County, California. This mining property, belonging to John S. Doe, of San Francisco, is very extensive, consisting of some thirty-six claims and parts of claims, with a well appointed fifteen-stamp silver mill.

The mines are situated in the heart of the Calico range of hills, and are reached by well constructed wagon roads, chiefly in the beds of three deep cañons. At the extremity of the ridge, between the junction of two of these cañons, the mill is situated, so that the ore can be delivered at the mill from any part of the property by a short down-grade haul.

The silver is found in the form of chloride and embolite chiefly, and impregnates, to a greater or less extent, all classes of the rocks.

The deepest openings in the district show some sulphide ores; hence we have a basis for the supposition that below the "water-line" the ore will change as usual to the prevailing sulphides.

The ore at present being worked in the Garfield Mill comes chiefly from three groups of mines, each supplying a slightly distinctive class of ore.

The first of these is the Oriental-Mammoth group. This supplies a rich, brittle ore, having a gangue of baryta in decomposed porphyry. This group of mines was bought from the Oriental Mill and Mining Company, and is now in good production.

The second group is the Silver Monument. This is a great mass of friable liparitic tufa, impregnated throughout with chloride of silver, from eight to sixty ounces per ton, and containing also some manganese and chloride of lead. The whole hill is being quarried out and sent to the mill, the cost of mining being less than 20 cents per ton.

The third and most important group is the Garfield-Occidental. The Occidental ore-bodies are very extensive and are chiefly in volcanic sandstone.

The Garfield ore-bodies have been very rich, and are found in the hard, massive liparite. The richness of the sorted ore first taken from the mine was phenomenal. To illustrate, I quote briefly from the Superintendent's report:

"Work begun on the Garfield Mine in December, 1882. Worked two men until April 1, 1883, and shipped eleven tons of ore which yielded $5,885. Then put on six men, and in the month of July following shipped to San Francisco thirty-three tons that yielded $26,440, and two hundred and thirty-three tons to the Oro Grande Mill that yielded $30,756. In September shipped ninety-six tons to the Odessa Mill that yielded $8,736, and nine tons that yielded $7,200, or about eight hundred ounces per ton. Stopped extraction of ore and began work on main tunnel. From November, 1883, to January 1, 1885, shipped to Odessa Mill two thousand four hundred tons of ore that yielded $290,400, and also had a large amount of unassorted ore worked at Barber's Mill."

The ore from these three groups of mines is mixed on the mill dump and milled in about equal quantities. In this way it yields up its silver readily to the simple pan process, the ore working up to about 85 per cent of the contained value. The continuous pan system is used.

The following is the tabulated result of the working of this property for one year, taken by permission from the books of the Garfield Mill, and the balance sheets of the Selby Smelting Company:

TABULAR STATEMENT.

Ores From the Doe Mines, Calico, Worked in the Garfield Mill.

	Bullion, Ounces.	Ore Milled, Tons.	Ores Assay Ounces per 2,000 lbs.	Cost of Milling and Hauling.	Cost of Mining.	Total.	Cost of Milling, per Ton.
1886—October	29,322	526	52.86	$3,714	$3,670	$7,384	
November	36,027	785	46.40	4,032	5,666	9,698	$4 52
December	35,232	878	45.61	3,809	6,898	10,707	4 58
1887—January	39,239	928	34.22	3,844	6,455	10,299	4 15
February	40,402	966	36.36	4,174	6,949	11,123	4 17
March	47,148	959	39.53	3,354	7,031	10,385	4 30
April	40,333	947	42.50	3,782	6,132	9,914	3 35
May	37,316	1,228	30.20	4,064	6,391	10,455	3 21
June	36,920	1,117	29.10	3,822	6,415	10,237	3 60
July	*24,879	984	32.60	3,370	6,226	9,596	3 97
August	*25,884	1,157	26.48	3,484	6,640	10,124	3 29
September	*24,513	1,001	26.00	3,446	6,519	9,965	3 10
Totals	417,215	11,476				$119,887	

* Ore extracted testing new mines.

OUTPUT OF THE KING MINE, CALICO DISTRICT, CALIFORNIA.

DATE.	Tons.	Value.	Gross Yield.	Dividends.
For the year 1883	6,000	$71 00	$426,000	$90,000
For the year 1884	13,000	39 00	507,000	290,000
For the year 1885	12,000	24 30	302,000	70,000
For the year 1886	6,000	20 00	120,000	None.
Totals	37,000		$1,355,000	$450,000

[The above figures are only approximate, but nearly correct, as remembered.—D. BAHTEN.]

SAN DIEGO COUNTY.

This, the second largest county in the State, takes its name from the mission founded here in 1769, the first established in Alta California. It is bounded by Los Angeles and San Bernardino Counties on the north, Arizona Territory on the east, the Colorado River being the dividing line between them; by the Mexican department of Lower California on the south; and by the Pacific Ocean, Los Angeles, and San Bernardino Counties on the west.

The Santa Margarita, the San Diego, and the Tia Juana Rivers are the chief streams in the county. In the winter and spring the volumes of water are very marked, forming a striking contrast to the summer and autumn when, owing to the sandy nature of the river beds, the water is at times invisible. In the southeastern part of the county, far out on the Colorado Desert, appears a river channel, some times flooded, but oftener dry, or nearly so, being filled only by back water from the Colorado River when at its highest stages. Coming upon the water, where none was expected, the early "voyageurs" across that region gave to it the name of "New River."

MINES AND MINING.

San Diego County, besides a variety of other useful minerals and metals, possesses a considerable wealth of gold and silver, chiefly the former, her

auriferous resources consisting of both vein and placer deposits, the latter not extensive. Salt is also produced in this county. Gold-bearing quartz lodes were discovered here as early as 1869, the site of these first discoveries being in the Cuyamaca Mountains, a high range, distant some sixty miles from the coast. The Julian, the Banner, and several other districts were afterwards organized here, many claims taken up, and much work done, this still continuing to be the principal quartz locality of the county.

From statistics prepared by Chester Gunn, Esq., of San Diego, it appears that the gold yield from these districts, from their discovery in 1869 up to 1880, was over $2,500,000. The surface rock being rich, it was a good camp for poor men. The advent of the Cuyamaca Railroad, now in course of construction to this section of San Diego County, will undoubtedly infuse new energy into these districts, and induce capital to develop the many promising ledges that have been partially opened. That this neighborhood has not yet been properly explored is shown by the fact that in the early part of this year, in a little valley five miles southeasterly from the town of Julian (at an altitude of four thousand seven hundred feet), seven locations had been made on small, rich veins of auriferous quartz, the croppings carrying free gold to such an extent that it seems almost impossible that for nearly twenty years it should have escaped the eye of the prospector.

Two of these claims, the Gold King and the Gold Queen, were examined. The country rock is granitoid gneissic, decomposed and soft in the immediate vicinity of the veins, but cropping in ridges of solid rock at a small distance from and between the veins, these having the same strike—namely, north 30 degrees west and south 30 degrees east. The dip of the veins is easterly at an angle of about 60 degrees. On the Gold King, at the time of our visit (in the beginning of May) an incline shaft had been sunk to the depth of twelve feet. We are informed that the shaft is now seventy feet deep, and the vein of rich quartz still continues.

GOLD-BEARING QUARTZ MINES.

THE READY RELIEF MINE.

This mine, taken up in 1871, and relocated in 1888, is situated in the Julian District, at an altitude of two thousand nine hundred feet above sea level. The vein strikes north 60 degrees west and dips to the northeast at an angle of 30 degrees. It varies in width from a few inches to several feet, the length of the pay shoot being undetermined; extent of claim, one thousand by six hundred feet. The mine is opened by three main tunnels, namely, lower, four hundred and fifty feet; second, four hundred and seventy-five feet; third, five hundred and thirty feet in length—all being on the vein. There is also a shaft seventy-five feet deep, at the mouth of the lower tunnel. The depths from the surface reached in the respective tunnels are: Lower, three hundred feet; second, two hundred and forty feet; third, one hundred and ninety feet. There is but little water encountered in the mine. The tunnels have been driven at the rate of two and one half feet per day, and the cost varied from $8 to $16 per foot, various kinds of powder being used. Tunnel No. 3 is timbered throughout; the others partially; stopes are not. The timber used is Douglas spruce, brought from a distance of two miles, and costs 8 cents per running foot.

The company employs, when working the mine, twenty men—seventeen in the mine and three in the mill—wages $2 50 to $3 per day; also six men on the outside. One mile of road and three fourths of a mile of ditch have

been constructed. The ore is quartz, carrying free gold and pyrites, and is extracted at a cost of $3 per ton, and is treated in the company's mill at the mouth of the lower tunnel by wet crushing, amalgamation, and concentration, yielding $15 per ton in free gold. The loss of quicksilver is 6 to 7 per cent of the amount used. The mill, which is now running, has ten stamps of nine hundred and fifty pounds each, dropping from four and one half to six inches, one hundred and five times per minute, and crushing fifteen tons of rock in twenty-four hours, or one and one half tons to each stamp, through a round-punched screen, set at a slight inclination, equal in fineness to a sixty-mesh wire gauze, and having a discharging surface of fifty-four inches by six inches. The shoes and dies are of cast-iron, costing six cents per pound, delivered; each set serves for the crushing of one hundred and fifty tons of ore. The aprons are each four and one half feet wide by six feet long, with an inclination of one inch to the foot, and are not silvered. Inside plates are six inches wide in back and front. The feeders are of original design and home manufacture. The concentrators, three in number, are the Hendy, employing water only from the battery. The concentrates amount to one per cent of the ore, and consist chiefly of pyrites, with a value of $100 per ton in gold. They are treated by grinding and amalgamation in an arrastra, at a cost of $3 per ton, and the recovery is 15 per cent of the value, or $15 per ton.

The mill is driven by a steam engine of forty-five-horse power, consuming three cords of wood in twenty-four hours, at a cost of $4 50 per cord for oak and spruce. The owners propose to use water for power with a fall of six hundred feet. The water is to be brought three thousand feet in pipes. It is also intended to procure an air compressor and drills.

There is no regular vein to be seen here, the quartz occurring in the form of discontinuous, sometimes curved, sheets, and peculiarly rounded masses encased in a conformable crust of slaty matter. The surface of the rocks in the tunnels is incrusted with sulphate of iron and alumina from decomposition of the clays and iron pyrites. The quartz seems to occur in and among the crushed, rent, and distorted slate along a line of fracture, suggesting its deposition by infiltration from the adjacent slate; and it is observed that the rock on each side of a disturbed belt of varying width retains its nearly perpendicular stratification or cleavage. Hence it has been supposed that this is an instance of true slaty cleavage resulting from lateral compression, which view, however, is scarcely sustained by the fact, as the different layers appear to differ in composition, indicating true planes of bedding.

Altitude	2,900 feet.
Vertical depth reached	300 feet.
Total length of tunnels	1,455 feet.
Depth of shaft	75 feet.
Number of feet timbered	600
Kind of timber	Douglas spruce.
Cost of timber	8 cents per running foot.
Cost of tunnels	$8 to $16 per foot.
Cost of mining	$3 per ton of ore.
Length of road built	1 mile.
Length of ditch built	¾ mile.
Number of stamps	10
Weight of stamp	950 pounds.
Drop of stamps	4½ to 6 inches.
Drops	105 per minute.
Duty of stamp	1½ tons in 24 hours.
Kind of shoes and dies	Cast-iron.
Wear of shoes and dies	One set to 150 tons.
Kind of screens	Round punched, equal wire, No. 60
Kind of feeder	Original.
Dimensions of aprons, length	6 feet.

Dimensions of aprons, width	4½ feet.
Percentage of recovery saved in battery	75
Percentage of recovery saved on aprons	20
Percentage of recovery saved in concentrates	5
Percentage of sulphurets	1
Value per ton of sulphurets	$100
Method of treating sulphurets	Amalgamation.
Cost of treating sulphurets	$3 per ton.
Percentage of value extracted from sulphurets	15
Yield of free gold in mill	$15 per ton.
Loss of quicksilver per ton of ore—per cent of what is used	6 to 7
Kind and number of concentrators	Hendy, 3
Horse power of steam engine	45
Consumption of wood per 24 hours	3 cords.
Cost of wood for fuel	$4 50 per cord.

THE STONEWALL MINE,

Located in 1870, is situated in the Julian District, at a point eight miles south from the town of Julian; altitude, four thousand seven hundred feet above sea level. This property includes three claims: The original Stonewall, four hundred and ninety-seven by seven hundred and one feet; second, six hundred by one thousand five hundred feet; third, six hundred by one thousand five hundred feet. The shaft at the time of our visit (in May) had been sunk here to a depth of two hundred and thirty feet, from the bottom of which a crosscut had been run to the vein. The ore occurs in shoots, which vary from one hundred to three hundred feet. The vein has a course north 35 degrees to 40 degrees west, magnetic, with a dip of 60 degrees or 70 degrees to the southwest, and an average width of six feet. Formation of both walls is gneissoid. The mine produces one hundred gallons of water per minute, which is handled by a six-inch Worthington pump. Ingersoll compressor, fourteen by twenty-four inches, is used to drive two No. 3 Ingersoll drills. Cost of running drifts, per foot, $12; cost of sinking and timbering shaft, per foot, $30. Cedar, pine, and fir are used for timbering, costing $20 per thousand feet.

The ore is transported to the mill over three hundred feet of trestle, and dumped into the bin at the rock breaker at a cost of 8 cents per ton. The character of the ore is free milling, and it is worked in a ten-stamp steam mill. Weight of stamps, seven hundred and fifty pounds each; drop, five inches one hundred times per minute, and having a crushing capacity of two tons per stamp in twenty-four hours. The shoes and dies are steel, and cost 9 cents per pound delivered at the mill. Two Frue concentrators are used, upon which the sulphurets, averaging one half of one per cent, are recovered. Cost of wood, $4 per cord. All work is now being done in shaft and mine with power drills, and the sinking of the shaft to a greater depth is being prosecuted with diligence. The country rock in the northeastern portion of the Cuyamaca Range, towards the desert, is granite. In 1872 there was near the mine a small lagoon in the bottom of the valley which drains the northeastern slopes of the higher portions of the Cuyamaca Peaks. This lagoon has recently, by an extensive dam, been converted into the "Cuyamaca Reservoir," and will now form the chief source of reserve supply for the water company engaged in transporting water from these high mountains to the City of San Diego (a distance of some sixty miles) and intermediate places.

In 1872 the Stonewall Mine had been worked for a width of twelve to fifteen feet (sometimes more) to a depth of about sixty feet below the surface, and the greatest depth of the mine was something over one hundred feet. There was at this time only a small, four-stamp mill at the mine, which could crush perhaps seven or eight tons of ore per day. Free gold

was visible now and then to the naked eye in the ore. In May, 1888, the main shaft of the mine was two hundred and thirty feet deep to the lowest level.

It is impossible to give any statement of the amount of total yield of this mine from the beginning. But it is safe to say that it has been large, and it is certain that some of its ore has been very rich. These facts, taken in connection with the circumstance that it has been more or less worked under many disadvantages for so long a period of time, certainly speak well for the mine, and there is no known reason why it should not continue to be a productive and profitable mine for many years to come.

Altitude	4,700 feet.
Number of stamps	10
Weight of stamp	750 pounds.
Drop of stamps	5 inches.
Drop of stamps	100 per minute.
Duty of stamp in twenty-four hours	2 tons.
Shoes and dies	Steel.
Size of screens	No. 40.
Dimension of apron plate	4 by 5 feet.
Length of sluice	12 feet.
Hendy Challenge feeders	2
Frue concentrators	2
Value of sulphurets	$40 per ton.
Length of ore shoot	100 to 300 feet.
Depth of ore shaft vertically	230 feet.
Quantity of water raised	90 gallons per minute.
Cost of tunnel	$12 per foot.
Cost of shaft (labor only)	$20 per foot.
Cost to transport ore to mill per ton	8 cents.
Average wages in mill	$3 50 per day.
Average wages in mine	$3 per day.
Average wages for outside work	$2 50 per day.

PAYMASTER AND EMILIA MINES.

These silver mines are situated about twenty-two miles northerly from the station of Glamis, on the Southern Pacific Railroad, and about thirty miles northwesterly from Fort Yuma, and eighteen miles westerly from the Colorado River. On the same vein as the Paymaster is the Emilia, each being one thousand five hundred feet in length by six hundred feet wide. The vein courses north and south and dips to the west at an angle of about 55 degrees. On the Paymaster the shaft is about three hundred and twenty-five feet deep; the two on the Emilia are three hundred and fifty and two hundred feet deep, respectively. The walls of the vein are a firm and compact porphyry. No water has as yet been encountered in the mine and very little timbering is required. The ore is quartz, containing some heavy spar and occasionally a little galena. The pay shoot is said to extend over one thousand feet. An air compressor and two Burleigh drills are in use at the mine. The ore is worked in a well appointed fifteen-stamp mill by the continuous Boss process; there are six pans. The engine is of one hundred and fifty-horse power, supplied with steam by two steel boilers, each four by sixteen feet. The silver bullion produced is on an average 002 fine in gold.

SAN DIEGO COUNTY.

By W. A. Goodyear, Assistant in the Field.

A considerable portion of the following report on this county is from notes taken in 1872.

Speaking in general terms of the broad mountain range, which, stretching southerly from the San Bernardino Valley, occupies all the western

part of San Diego County, viz., that part which is bounded east by the Colorado Desert, west by the Pacific Ocean, and south by the republic o Mexico, it may be said to be essentially a granite range. Probably more than nine tenths of the whole mass of this range consists of granitic rock, which, however, varies largely in texture, and to a considerable extent also in its mineralogical composition at different localities, much of it being more or less syenitic in character.

In many places, however, and more particularly in the eastern portions of the range, the granite is traversed here and there by narrow belts of very highly metamorphosed and crystalline, micaceous, and hornblendic slates and schists, which usually have a northwesterly trend; and various qualities of limestone and marble occur at some localities. Moreover, the western foot of the range along the coast, is much of the way flanked to a greater or less extent by almost unaltered accumulations of comparatively recent origin. But the aggregate quantity of all these formations compared with that of the granitic rocks which constitute the great mass of the range, is as stated above extremely small.

The detailed topography of this broad mountain region is very complex, the different ridges trending in many different directions, and inclosing amongst and between them many small valleys at various altitudes above the sea, some of which contain considerable good farming land, though none of them are very large.

As we go inland, the mountains gradually increase in height till at an air line distance of about fifty miles from the coast we find the highest crests of the range at altitudes of between six thousand and seven thousand feet above the sea.

Going still further east, the descent of some five thousand feet from these culminating crests to the western edge of the Colorado Desert is very steep and rapid, thus showing a strong resemblance in the general form and outline of the range, though on a considerably smaller scale, to the shape assumed by the Sierra Nevada itself through the more central regions of the State.

These remarks hold good in a general way of the whole range, until we reach the northern portion of the county, where a more decided easterly and westerly trend of some of the heavier mountain ridges begins to make itself felt, and where, close to the San Bernardino County line, the grand peak of San Jacinto towers to an altitude, as stated by Lieutenant Wheeler, of ten thousand nine hundred and eighty-seven feet above the sea.

For a detailed description of this broad region, a beginning will be made by the present writer at the monument on the Mexican boundary line, some fifteen miles southeasterly from the City of San Diego. This monument is of marble, and consists of a square pedestal capped with a pyramid, the top of which is some twelve or fifteen feet high above the ground. The magnetic course of the boundary line from the monument towards the east on April 24, 1872, was north 71 degrees east.

The monument itself is within about two hundred yards of the shore of the ocean, and is between fifty and seventy-five feet above tide, on the mesa.

For two or three miles, at least, to the east from the monument, the boundary line runs along the northern edge of a mesa whose bluffs, fronting towards the north along the southern edge of the Tia Juana Valley, are some of them at least five hundred feet high.

At an estimated distance of ten or twelve miles southwest from the monument are Los Coronados Islands. These are a little group of three or four small rocky islets in the ocean, which belong to Mexico, the largest

of which may be one mile in length, and is, probably, four hundred or five hundred feet high above tide.

A similar mesa formation, consisting chiefly of recent gravels, extends all the way south from San Diego to the boundary line. Some of the way it forms low bluffs, twenty-five to thirty feet in height, fronting westward towards the bay; and again it forms no bluffs at all, but rises gradually with a very gentle slope for several miles towards the east. It is often cut to depths of fifty to two hundred feet by various creeks and gulches, such as Las Chollas Valley, Sweetwater Creek, the Otay Creek (where Captain Wilcox's ranch was located in 1872), and the Tia Juana River, still farther south, and close to the Mexican boundary. The Otay runs into the southern head of San Diego Bay; but the Tia Juana runs into the ocean just north of the boundary line.

The mesa formation immediately south of the Tia Juana rises in bluffs which I estimate at five hundred to six hundred feet high, and then continues to rise towards the south till it reaches an elevation of one thousand five hundred feet or more above the sea, forming the "table mountains," which are visible from here towards the south in Mexico.

For many miles north and south, to the east of the City of San Diego, the height to which the mesa formation reaches is from five hundred to eight hundred feet above the sea.

In 1872 they were manufacturing salt both on the Sweetwater Creek, near National City, and also near Captain Wilcox's ranch on the Otay.

In an artesian well, sunk by Mr. Callaway prior to 1872, on the east side of the bay, at a point where the mouth of the well was ninety-four and one half feet above high water, the following strata were passed through:

Surface soil, sand beds, and loose gravel	100 feet.
Calcareous sandstone, full of shells	2 feet.
Blue clay	60 feet.
Stratified sandstones	15 feet.
Coal	3 feet.
Sandstone	54 feet.
Cavity with water	11 feet.
Slate rock with some coal	5 feet.
Slates	44 feet.
Total depth of well	294 feet.

The lower portion of the San Diego River from the point two or three miles above the locality of the Old Mission, where it issues from the mountains proper, is dry in summer; and this portion of its valley ranges from a quarter to half a mile in width, and is cut from one hundred to three hundred feet deep through the mesa formation, which here rises to an altitude of six hundred or seven hundred feet against the mountain sides.

Following up the river cañon, the first rocks which we find in place are a series of dark-colored, very hard, and highly metamorphosed beds, which strike northwesterly and dip southwesterly at angles of from 10 degrees to 15 degrees. Much of this rock is a peculiar amygdaloidal pebbly conglomerate. But there is also much of a dark-colored, very fine-grained, and nearly homogeneous amygdaloid, and there are also here and there what seem to be dikes of nearly black, fine-grained, hard and compact eruptive rock. These rocks are evidently older than the mesa formation which they underlie. Two or three miles farther up the cañon they all disappear, and we come upon a rather fine-grained syenitic rock, consisting chiefly of feldspar and hornblende, with but little quartz and almost no mica, which might almost be called a diorite. Much of the feldspar in this rock has

a pinkish tinge. This rock then continues along the cañon up to the site of the dam built by the old Mission Fathers at the foot of the Cajon Valley, whence they conducted the water in an aqueduct, constructed of tiles and mortar, some eight or nine miles to the mission in the valley below.

At a little distance to the south of the river cañon the mesa formation extends uninterruptedly from the bay back to the southwest edge of the Cajon Valley itself; but on all other sides this valley is surrounded by the granitic rock in place. The altitude of this valley above the sea is some eight hundred or nine hundred feet, and its greatest length is in a northwesterly direction to the San Diego River, which drains it. In the southeastern portion of the valley is the fine ranch of Major Levi Chase, who owns some two thousand two hundred acres here, about two hundred of which are in bearing orchards and vineyards.

Going northerly some twenty-one miles from the Cajon Valley across the mountains to the Santa Maria Valley, we traverse a country consisting almost exclusively of granite, which often contains dark-colored hornblendic nodules, and is here and there cut in various directions by feldspathic veins; while at one locality there also occurs a very narrow belt of dark-colored and very highly metamorphosed hornblendic slates.

In the Santa Maria Valley a town has been laid out, and a hotel with a few other buildings erected, at a place called Ramona, which is on the northeast quarter of Sec. 15, T. 13 S., R. 1 E., S. B. M. The aneroid barometer here read one thousand four hundred and thirty feet.

Following the stage road in a general direction a little north of east from Ramona, through Ballena and Santa Ysabel Valleys to Julian, a distance of about twenty-one miles, no rock is seen but granite until within about one mile from the town of Julian, where we find a belt of micaceous schists, which strike northwesterly, and dip at high angles to the north and northeast. The granite country here is frequently traversed by veins of very coarse granite, which sometimes furnish plates of mica one or two inches in diameter, with correspondingly large cleavage blocks of feldspar. Very often, also, these veins contain large crystals of tourmaline, which are very black, but are rarely perfect in form. Some of them taper almost to a point at the ends; but I saw no crystals with well-formed terminal planes, though some of them were an inch or more in diameter, and several inches long. They are generally quite fragile and break easily, so that it is difficult to procure good specimens.

At the time of our visit to Julian, on May 2, 1888, there were no mines actively working. The Owens Mine and Mill were closed down. This mine is located about half a mile northwest from the town, on Sec. 31, T. 12 S., R. 4 E., S. B. M. It is a quartz vein, conformable with the inclosing micaschists, which strike about north 70 degrees west, magnetic, and dip at a high angle to the northeast.

It was visited by the writer in 1872, when it was working. The vein ranged from two to four feet thick, and they were then down upon it about two hundred feet with a shaft which at that time was the deepest one in the district. I was also shown in San Diego in April, 1872, about $10,000 worth of gold bars, said to have been obtained from about one hundred and fifty tons of ore from this mine, with a ten-stamp mill in a ten days run. A thin streak in this vein has been extremely rich in handsome specimens of free gold, some of which were also shown to us at the time of our visit in 1888.

The town of Julian is just about at the watershed of the range, and is probably a little over four thousand feet above the sea, the aneroid reading at the hotel on May second, four thousand one hundred and eighty

feet. It is on Sections 5 and 6, while Banner is on Section 3—both of them in T. 13 S., R. 4 E., S. B. M. By the wagon road, however, the distance from Julian to Banner is about six miles, and the latter place is some thirteen hundred feet lower down on the eastern slope of the range.

Between Julian and Banner a broad belt of granite intervenes. But Banner is again in the schists, which, in the creek near D. D. Bailey's house, strike north 60 degrees west, magnetic, and stand nearly vertical. At the Ready Relief Mine the slates are talcose, micaceous, and argillaceous, and strike about north 50 degrees west, magnetic, and dip 75 degrees to 80 degrees to the northeast. The vein, more particularly described in another portion of the report, appears to be generally conformable with the slates.

On May fourth we visited two new and very recent discoveries of rich gold quartz only a few hundred feet apart, on the southeast quarter of Sec. 15, T. 13 S., R. 4 E., S. B. M., called respectively, the Gold King and the Gold Queen, where the aneroid barometer read four thousand seven hundred feet.

The rocks here are a hornblendic gneiss, which strikes about north 25 degrees west, magnetic, and dips from 60 degrees to 70 degrees to the northeast. At the Gold King claim a hole had been dug some twelve or fifteen feet in depth, exposing, however, no single vein of any considerable size, but several small stringers of quartz, none of which were more than two or three inches in thickness, but some of which were extremely rich in very coarse gold, some of the hand specimens found here showing gold at rates of probably $40,000 to $50,000 per ton. At the Gold Queen claim only a little hole some two or three feet deep had been dug, but here also a small quantity of the same character of extremely rich gold quartz was found.

On the twenty-ninth of April, 1872, the present writer ascended the highest peak of the Cuyamaca Mountain, whose altitude is between six thousand and seven thousand feet above the sea, and which is the culminating peak of all this portion of the range, no other one rising so high until we reach the higher portion of the San Jacinto Range in the northern part of the county. The mountain consists mainly of syenitic granite, frequently passing into syenite and sometimes into diallage or hypersthenic rock.

The view from the summit of this peak is very extensive, reaching towards the south far into the republic of Mexico, and towards the north as far as the San Jacinto Peak and Mount San Bernardino, while to the west and southwest the shore for many miles, together with a very broad expanse of the ocean, are in sight, and to the northeast a considerable part of the Coahuilla Valley or the northwestern part of the Colorado Desert, and beyond it a long stretch of the southeastern continuation of the San Bernardino range of mountains running towards the Colorado River along the northeast side of the Desert Valley, can also be seen. This is the best point from which to obtain a bird's-eye view of the general form and character of the mountains in the western part of San Diego County.

Looking down from this standpoint over the surrounding region, the whole country from just back of San Diego easterly to the western edge of the desert, is like an angry ocean of knobby peaks more or less isolated, with short ridges running in every possible direction, and inclosing between and amongst them numerous small and irregular valleys. As a general rule the higher peaks and ridges rise from one thousand to two thousand five hundred feet above the little valleys and cañons around their immediate bases. But in going easterly from the coast, each successive little valley is higher than the one immediately preceding it, and the dominant peaks and ridges are also gradually higher and higher above the sea until

we reach the irregular line of the main summit crest, or water divide of the range, when the mountains break suddenly off, and fall within a very few miles from four thousand to five thousand feet or more, with an abrupt and precipitous front towards the east, to the western edge of the desert.

It thus follows that this chain of mountains, as already stated, though made up of a confused mass of minor ridges and peaks of granite, having in their detailed topography but little connection with, or relation to, each other, nevertheless has a general orographic form very closely allied to that of the Sierra Nevada in the more central portions of the State. The writer was also informed that the "wash," or accumulation of loose materials derived from the eastern slopes of these mountains, is very heavy, and stretches easterly from the foot of the mountains proper for distances sometimes of fifteen or twenty miles into the desert, descending eight hundred to one thousand feet or more towards the lower portions of the valley, thus forming a perfect parallel to the sagebrush slopes along the eastern foot of the Sierra Nevada in Owens Valley.

Throughout this region the occurrence in the granite of very dark-colored hornblendic nodules, whose texture, however, is still granitoid, is very common.

It may not be out of place to publish here a series of magnetic bearings taken by the writer from the summit of Cuyamaca Peak to various points of interest, on April 29, 1872. They are as follows:

Soledad Mountain	S. 52¼° W.
Cajon Peak	S. 53 W.
San Diego River Cañon at foot of Cajon Valley	S. 47 W.
Mission Mountain	S. 43 W.
Point Loma	S. 37 W.
San Miguel Mountain	S. 21 W.
Los Coronados (Southeast Island)	S. 19¼ W.
Valle de los Viejos	S. 12 W.
Highest San Ysidro Peak	S. 6 W.
Lyons Peak	S. 4 W.
Table Mountain, in Lower California	S. 1¼ E.
High, round mountain in Lower California	S. 14 E.
Tecaste Mountain	S. 15 E.
Guatay Valley	S. 20 E.
Very distant, high peaks in Lower California	S. 32 E.
Guatay Mountain—highest peak	S. 38 E.
Harpers Valley	S. 51 E.
Samagatume Valley	S. 51½ E.
Pine Valley	S. 55¼ E.
Central portion of Cuyamaca Valley	N. 20 E.
Third Cuyamaca Mountain	N. 2 E.
San Jacinto Peak	N. 19¼ W.
Mount San Bernardino	N. 24½ W.
Santa Ysabel Valley	N. 27 W.
Warner's Ranch	N. 32¼ W.
Julian, not visible, but about	N. 4 W.
Temescal Range	N. 55 W.
Temecula Mountain	N. 59½ W.

From the Stonewall Mine, the following distances were recorded by the odometer, May 5, 1888: To Descanso, twelve miles; thence to Las Viejas, seven miles; thence to Alpine Station, seven miles; thence to Knox's Hotel, in the Cajon Valley, fourteen miles.

At Descanso, the aneroid barometer read three thousand five hundred feet, and at Alpine Station, one thousand nine hundred feet.

About half a mile west of Descanso, a shaft was once sunk some twenty or twenty-five feet on a little stringer of quartz, accompanied by a little bunch of slaty rock, the whole of which strike nearly east and west through the granite, and dip to the north. The granitic rock along this route varies a good deal in texture, etc., at different localities. Much of it seems to be

more or less syenitic; while occasional veins and isolated bunches of very coarse granite also occur amongst the rest.

On the twenty-eighth of April, 1888, our party visited a locality called La Joya, nowadays misspelled La Jolla, on the seashore, thirteen miles northwest of San Diego, and some four or five miles north of the north end of False Bay. Here a large hotel (unfinished at the time of our visit) and some cottages are situated on the narrow mesa, about one hundred and forty feet above the tide. The bluffs, fifteen to forty feet high, facing the ocean in front of the hotel, are unaltered sandstones, generally rather soft, with occasional intercalated beds of somewhat harder clay shale, and here and there a layer of coarse conglomerate, containing large bowlders of various metamorphic rocks, with occasional granite pebbles, and now and then a fragment of eruptive rock—the whole dipping from 5 degrees to 20 degrees southwesterly, and here and there somewhat faulted. The ocean fauna along the shore here is rich, and from one point gold fish can be seen disporting in the water around a rock covered with seaweed. The climate is agreeable, and the place will undoubtedly become a very pleasant seaside resort.

Messrs. Coppin & Loud, of 743 Sixth Street, San Diego, have some gold claims which we did not visit, located near the southwest corner of Sec. 1, T. 18 S., R. 2 E., S. B. M. They showed us some good looking rock from there, some of which they asserted had shown assay values of 8.8 ounces of gold per ton. They have also called their claims Gold King, though they are a long distance from the claim of that name above described.

For the next few pages the writer will confine himself to his notes of 1872, in which year he made a trip in the saddle with Dr. J. G. Cooper through the region bordering the coast from San Diego to Los Angeles.

Commencing at the Mexican boundary line, the mesa formation, of pleiocene age, is some ten or twelve miles wide, and from thence it forms an uninterrupted belt of varying width for a distance of more than fifty miles along the coast towards the northwest, or as far as the Santa Margarita River. Immediately at the coast it is usually rather low, though bluffs of forty or fifty feet in height occur. But as we go back from the shore it gradually rises, and on reaching the foot of the mountains sends out here and there long and broad arms or branches among the foothills, some of which extend inland as far as eighteen or twenty miles from the coast, and reach maximum altitudes of more than a thousand feet above the sea.

The Point Loma Ridge and the Soledad Mountain, which last lies north of False Bay, just back of La Joya, rise several hundred feet above the tide and above all the surrounding mesa. They consist of very similar materials to those which form the mesa, but more solidly cemented together, and are probably of somewhat older origin. The summit of the Soledad Mountain is about seven hundred feet above the sea, and the stratification here seems to be nearly conformable with the slope of the mountain, rising very gently from False Bay to the summit, and then pitching suddenly down with dips of from 30 degrees to 40 degrees toward the north.

East of the mesa formation there are in places considerable quantities of very highly metamorphic crystalline strata, distributed in irregular belts and patches along the lower portions of the mountains for a long distance towards the northwest. The Cordero Mountain, just south of the San Dieguito River, consists of rocks of this sort; though the hills two or three miles to the east of it are granite.

For several miles northwest from the Soledad Mountain, the edge of the mesa fronting the ocean is somewhat higher than it is a little farther back from the shore.

From Los Encinitos to San Luis Rey, a distance of fourteen miles, the mesa is much narrower, ranging not over six or eight miles in width, and the hills are much smoother and more rounded in their outlines than is the case farther south, and bluffs or escarpments are rare. Also there is along here in places considerable metamorphic rock bordering the granite.

The San Luis Rey Valley, below the mission, is about one mile in width, and the soil is rich. The San Luis Rey Mission Church was, in 1872, in a better state of preservation than almost any other of the old mission churches in the State. The granite comes down here in the low foothills almost as far as the mission.

In the valley of the Santa Margarita River, the granite extends southwesterly as far as the old Ranch House of Don Juan Foster, who was living there in 1872, and owned the great ranch of Santa Margarita y Las Flores.

The hills below here, towards the ocean, though probably of tertiary age, seem to have been considerably disturbed, the strata dipping southwesterly at angles sometimes as high as 20 degrees or 25 degrees.

Beyond the Santa Margarita River, towards the northwest, the mesa formation is not so prominent, and the hills of earlier date come down closer to the shore, until within a few miles of the mouth of the Santa Ana River, where they disappear beneath the plain.

Four or five miles southeasterly from Don Juan Foster's house, a very prominent and steep but round-topped hill, called El Moro, rises to a height of eight hundred or nine hundred feet above the sea. This hill was climbed, and found to consist of a very fine-grained, light-yellow sandstone, of very uniform texture, but slightly metamorphosed if at all, and not very hard. It varies considerably, however, in hardness, and some of it is about as hard as the Angel Island sandstone of which the Bank of California in San Francisco is built. This hill rests upon the granite. It is completely isolated, and rises two hundred and fifty or three hundred feet higher than anything else in its vicinity. It is situated also almost in the center of a nearly circular amphitheater of lower hills, surrounded by high mountains, and opening out towards the south and southwest into the rolling mesa country. The radius of this amphitheater is probably at least five miles. Within this area the hills are chiefly granitic, though small patches of stratified but very highly metamorphosed rocks appear to be scattered irregularly through them. The greater portion of their surface is covered with soil which often seems to be of considerable depth, though little outcrops of the solid underlying rock are frequent everywhere.

From Don Juan Foster's house, the distance by the wagon road, in a northerly direction over the hills, to Las Pulgas Valley, on Las Flores Creek, at the southern foot of the Santa Margarita Mountains, is about seven miles. These mountains, estimated to be two thousand five hundred to three thousand feet high, appear to form a short ridge, running a little north of east and south of west along the north side of Las Flores Creek. They are very steep on their south side, and furrowed by very numerous gulches with very steep sides. Oak timber is plenty about the mouths of the cañons and in the little valleys scattered about the foot of the mountains. Higher up their slopes there is a belt without any timber. But about the summits they are again timbered to some extent with oak, and the timber on their northern slopes is said to be heavy.

The lower hills immediately surrounding Las Pulgas Valley are granite, covered with soil or granitic gravel, and sometimes with more or less of a

stratified formation like that of the mesa. A white sandstone, probably of the same age as the mesa, also remains here and there, in nearly horizontal patches, on the tops of the hills skirting the foot of the mountains. The latter are flanked on their southern side by a heavy mass of highly metamorphosed and siliceous slates and sandstones, in which the stratification has been greatly obscured. They seem, however, to have a general easterly and westerly strike, and very high angles of dip. There is a good deal of semi-jasper here, with some very fine-grained quartzite, also some syenitic rock and dikes of basalt. The higher parts of the range are granite.

From the Las Pulgas Valley down the creek to Las Flores Station, on the old stage road, is about five miles. For a considerable portion of this distance the creek passes between mountains that are nearly or quite one thousand feet high on either side. These mountains consist chiefly, if not entirely, of reddish and bluish sandstones and conglomerates, the latter greatly preponderating in quantity. Much of this conglomerate, however, is, more properly speaking, a rock half way between a conglomerate and a breccia, the pebbles and bowlders which it contains being only partially rounded. These bowlders consist of quite a variety of hard metamorphic rocks, with fragments of granite, quartz, etc., and the strata are so heavy-bedded that it is not easy to make out their position. I think, however, they are generally not far from horizontal, though probably they have been somewhat disturbed.

For five or six miles northwest of Las Flores the road runs close to the shore along the foot of the San Onofre Mountains. These mountains, whose highest point is probably one thousand feet or more above the sea, seem to consist of the same sandstones and conglomerates as those along Las Flores Creek. A new feature, however, shows itself here in the fact that on the side fronting the sea these hills are terraced; and at one locality three distinct terraces were noticed above the road, making, with the bluff along the beach, four terraces in all, marking as many different periods of uplift of the coast. The highest terrace was estimated to be two hundred and fifty or three hundred feet above the tide.

The San Onofre Mountains continue to San Mateo Creek, near the mouth of which was a stage station, called San Mateo, close to the boundary line between San Diego and Los Angeles Counties. I now turn again to my notes of 1888.

The new town of Oceanside has been built on the mesa a short distance to the south of the mouth of the San Luis Rey River. There is here a broad beautiful sandy beach, backed by a line of bluffs, twenty to twenty-five feet high, consisting of recent sandstones, rather soft, thinly bedded, and lying nearly horizontal.

From Oceanside we went, May 9, 1888, to the new town of Escondido, which is situated southeasterly from Oceanside, and nearly at the center of the Rincon del Diablo Ranch, not far from the southwest corner of Sec. 14, T. 12 S., R. 2 W., S. B. M., and is about seven hundred feet above the sea. The distance by rail from Oceanside to Escondido, according to Crocker's "Railroad Gazetteer," is twenty-five and seven tenths miles. Along the eastern border of the mesa formation, which here is only some six or eight miles wide, there is in this region a belt of no great width of highly metamorphic and "blocky" sandstone. But, about half way from Oceanside to Escondido, the granite sets in, and then continues to form the mass of the country further east.

About two miles southeast of the town of Escondido, we visited a quartz vein, which strikes about north and south, magnetic, through low rolling

hills of soft decomposed granite, and dips to the west at angles ranging from 20 degrees to 40 degrees. There is much feldspar also in this vein, which runs from six to eighteen inches or a little more in thickness. As much as twenty years ago, this vein was worked for gold for a distance of half or three quarters of a mile along its strike, and down to water level a depth of about eighty feet measured on the dip. One slope is said to have been sunk to the depth of two hundred and seventy-five feet on the dip; but no stoping of any importance was done below the eighty-foot level. The vein, though narrow, is said to have been very rich.

A little to the east of here, and near where the old ranch house used to be, some placer gold was also taken from the bed of a creek which runs southward to the San Dieguito River. The ore from the quartz vein was at first worked in an arrastra; but afterwards a five-stamp mill was erected, which, however, has subsequently disappeared. At a point half a mile or more to the north of the old workings, a slope is now being sunk, going down with a pitch of about 20 degrees in a direction north 50 degrees west, magnetic. The vein here ranges from four to twenty-eight inches in thickness, and looks quite promising. About half a mile northwest from here, there are in the granite some very heavy outcrops of extremely white quartz. Some of these outcrops are fifteen to twenty feet or more in width, and they occasionally contain very large crystals of orthoclase, some of which are six or eight inches long and four or five inches wide. But no mica was seen here, nor has any gold been found in this quartz.

On the Hicks tract, some three miles northeast of the town of Escondido, there is a heavy body of siliceous porphyritic rock, through which runs a vein of porphyry, with some quartz, two to three feet thick, which has been worked to some extent along the surface, and is said to have prospected well. The little creek which runs past the town is now called the Escondido River. It is a branch of the San Elijo Creek.

From the old Ranch House of Don Juan Foster, on the Santa Margarita y Las Flores Ranch, the California Southern Railroad going northeasterly follows up the cañon of the Santa Margarita River for a distance of about twenty-five miles to Temecula Station. For nearly the whole distance, the cañon, the upper portion of which is also called Temecula Cañon, is deep and narrow and very crooked, the rocks all being granitic and syenitic, with the exception of small patches here and there of very dark-colored hornblendic schists. Some of the granitic rocks are traversed by very extensive cleavage planes. Temecula Station is close to the head of this cañon, and in the latter, some two miles below the station, a quarry has been opened which furnishes a rather light-colored granite, which certainly splits and works beautifully, and which, so far as could be judged from its appearance in passing on the cars, is probably a first class building stone.

Most of the rock seen along the line of the railroad from Temecula to Perris, is also granite, although between Elsinore and the latter place there are some very highly metamorphosed slates.

The altitude of Perris above the sea is not far from one thousand five hundred feet. The hills just west and northwest of Perris are granite, as are also the rocks so far as seen in the region to the east and southeast, between Perris and San Jacinto.

At old San Jacinto, Mr. Daniel Clark has just back of his livery stable an artesian well three hundred and eight feet deep, which discharges from the top of the pipe, ten feet above the ground, some three or four miner's inches of water. The well is piped all the way down, and is pierced at several different depths. The owner of La Palma Hotel also has several

artesian wells, one of which is said to be only twelve feet deep, and is flowing. Most of these wells furnish water which contains some sulphur.

On May twelfth we visited the foot of the mountains some two or three miles northeast of San Jacinto, and ascended their southern slopes to a height of about one thousand feet above the valley. These mountains are a part of the high range stretching about west-northwest from the San Jacinto Peak nearly to Colton, and forming the southern boundary of the eastern part of the San Bernardino Valley and the San Gorgonio Pass. Nearly all the southern flank of the range, as high as we went, consists of micaceous slates and shales, though at one point about five hundred feet above the valley there is a considerable mass of granite, and not far distant, in the face of a cliff some two hundred or three hundred feet higher, a bed of crystalline white limestone or marble is exposed for a distance of a few hundred feet, and appears to be conformable with the slates. The prevailing strike of the latter is easterly and westerly, and their dip at high angles to the south. But they are also considerably disturbed, and in some places strike and dip in different directions. Where the marble crops, the strike is northerly and the dip easterly. Mr. Bryant, who lives here in the valley by the river, and who has been almost all over these mountains, states that these metamorphic rocks do not extend much farther up their southern flank than the highest point we reached to-day, and that all of the central and highest parts of the range are granite. We saw a number of outcrops of quartz where a little prospecting had been done, and it is said that an assay from one of them gave $10 in gold and $17 in silver per ton. At no place, however, had work enough been done to prove whether any vein can be traced for any considerable distance. The quartz here occasionally contains some tourmaline, and at one point an outcrop of coarse granite was seen in which the feldspar cleavage planes were some of them an inch or two broad.

There are numerous other localities in these mountains to the east and southeast, as well as to the west from here, where some prospecting has been done, and some rich quartz is said to have been found, and a good many claims located. But no mine of any importance has ever yet been developed within a radius of twenty-five or thirty miles around San Jacinto. White marble is also said to exist at various other places, scattered along in the range to the west from here, and some specimens seen at San Jacinto were very coarsely crystalline, like much of that in the Slover Mountain near Colton.

At the foot of the mountains, about north 25 degrees east, magnetic, from La Palma Hotel, there are said to be some hot sulphur springs, which, however, we did not visit.

About three miles southwest of Perris, some asbestos has been found in a belt of slates inclosed in the granite. The strike appears to be about north 70 degrees west, magnetic, and the dip nearly vertical. It is only exposed in an open cut fifteen or twenty feet long and six or eight feet deep.

On Sec. 33, T. 4 S., R. 4 W., S. B. M., is what is now known as the Consolidated C. C. Mine. It is a vein of quartz one to two feet thick, striking about north 50 degrees east, magnetic, and dipping about 60 degrees to the southeast, accompanied by some slate in the granite. This vein has been worked for a length of several hundred feet, down to the water level. The water in the old works now stands within twenty or twenty-five feet of the surface of the ground. They say that the rock taken out from here yielded from $30 to $40 per ton. It was owned by Jerry Shay and O. Wright.

A short distance northwest of the asbestus locality above described, a heavy vein of quartz, stained very black with manganese, strikes about north 60 degrees west, and dips steeply to the northeast. This is in a belt of slate, which, however, is of no great width in the granite.

The Plomo Mine is on Sec. 32, T. 4 S., R. 4 W., S. B. M. It is a quartz vein ranging from nothing up to three feet in thickness in the granite, strike, nearly north and south, dip, westerly some 35 degrees. Some of the ore shows free gold quite plentifully to the naked eye, and also contains considerable galena, which is often rich in silver, having yielded assays as high as $800 in gold and one hundred and twenty-five ounces of silver per ton. It has yielded in the arrastra over $80 per ton. A small lot worked in a mill gave $31 per ton. From the south side of the hill, a tunnel runs some four hundred feet north 10 degrees west, magnetic, the strike of the vein being probably north 15 degrees to 20 degrees east, magnetic. The tunnel then turns considerably more towards the west, and runs about one hundred feet farther. The mouth of the tunnel is in soft granite; but it soon passes into a belt of hard, dark-colored slates, and then strikes hard granite. The last one hundred feet, however, follows a narrow band of slate with a little seam of quartz. The mine is owned by H. C. Stule.

A mile or two northwest of here is the little Mexican settlement called Gavilan, just southeast of which is the old Santa Fé Mine, where no vein is visible, but where a good deal of work has been done along a line which strikes approximately east and west magnetic, while the workings in the rotten granite dip about 60 degrees to the south. A tunnel has been driven here about two hundred and eighty-five feet in a southerly direction, but has not reached what they call the "vein." Considerable gold must have been obtained here, however, as the workings extend for a distance of four hundred or five hundred feet along the hillside. They are idle now.

Two or three miles northwest from here was the Gavilan Mine, said to have been a quartz vein ranging from one inch to three feet thick, and very rich. It too is idle now.

A short distance east of the Sante Fé is the Rosario, or Northern Belle Mine, which strikes about northwest, and dips some 45 degrees southwest. Here also the vein is very indistinct, and the country is all granite, some of it being syenitic, and occasionally more or less porphyritic.

Many other little seams occur in this region, and there has also been considerable shallow placer mining done here in the past.

This is the Pinacate Mining District. It contains no mills at present except one five-stamp mill at the Good Hope Mine, some four or five miles further southeast. This last mine we did not see; but it has the reputation of a good mine, and it is said that the large new South Pacific Hotel at Oceanside was built out of one fourth of its proceeds.

Speaking generally of the history and prospects of gold mining in San Diego County, it may be said that while a good deal of prospecting and surface scratching has been done at various localities, yet the total aggregate amount of intelligent and systematic mining which has ever yet been done within the limits of the county is extremely small.

This has been due to a variety of causes: First, most of the mines are situated at considerable distances from any points which have hitherto been very easily accessible to travelers, and very little has been known about them outside of the county itself. Second, there has existed from the beginning a widespread but unreasonable and unfounded prejudice against the county, which has rendered it almost impossible to induce capitalists to invest any money in mines that are located there. Thus,

most of the mines have in the past been owned and worked by men who were comparatively poor and had not the requisite means to properly develop them, which accordingly they failed to do. Other mines have shut down for other causes, which were not the fault of the mines themselves, such as unskillful and incompetent management (which will ruin any mine); costly litigation, which always arises to a greater or less extent wherever rich mines are found, etc.

Yet many of these mines have yielded large sums in the past and some of them are to-day running and doing well.

The chief cause of the prejudice against this region appears to lie in the facts that most of the country is granite, and that some of the ores are enormously rich; and from these facts the conclusion has been jumped at that such veins must be too "spotted" and "pockety" to pay to work. But this inference is by no means justifiable. *All* gold-quartz veins, everywhere, are more or less "spotted" and "pockety" in the distribution of the gold which they contain. And the mere fact that such a vein contains, here and there, some immensely rich streaks and pockets, is certainly *per se*, a very strange argument to adduce against the value of the mine. But, it is asserted, that veins in the granite are always more "pockety" and unreliable than those in the slates. I know that such an impression has been widespread for many years, even among well-informed and experienced mining engineers, and there may perhaps be some truth in it. But it is very far from being universally true, and some very valuable mines have been found in the granite. Moreover, San Diego County is not all granite. There are many patches and belts of metamorphic slates scattered here and there throughout the country, and many of the mines themselves are in the slates and not in the granite. This is the case with the Stonewall, as well as with most of the mines about Julian and Banner.

The prejudice against this region is, therefore, both unreasonable and unjust. And there is every reason to hope that, with the further construction of railroads, the wise investment of capital, and skillful management of the mines, the time is coming when San Diego County will take a very respectable rank among the gold-producing counties of the State.

It is undoubtedly true that the great mass of this whole range of mountains belongs essentially to the same geological age as does that of the Sierra Nevada itself through the more central portion of the State.

SAN FRANCISCO COUNTY.

The Presidio was established in 1776 within the present limits of San Francisco; having been founded on the day dedicated in the Roman Catholic calendar to St. Francis de Assisi, the new military station was given his name. Afterwards, when a city came to be laid out on the site already occupied by the hamlet of Yerba Buena, to the new town was given the name originally conferred on the Presidio, but which, as applied to that post, had fallen into disuse. The County of San Francisco is bounded on the north by the Golden Gate, on the east by the Bay of San Francisco, on the south by the County of San Mateo, and on the west by the Pacific Ocean.

NATURAL FEATURES.

The surface of this county, which occupies a peninsula formed by the Bay of San Francisco and the Pacific Ocean, is rugged, three fourths of it being broken into high hills, eroded by deep ravines, and separated from each other by valleys and uneven plains, some of the latter being of considerable extent. On either side of this peninsula occur patches of low lying lands, portions of those on the bay side being submerged at high water. There are no streams of any size in the county. Laguna de la Merced, situated near the ocean beach, six miles southwest of the city, with some other still smaller lakes, the most of them mere ponds, constitute the only bodies of permanent water within the limits of the county. The sparse growth of scrubby oaks that once grew on the hills having all been cut away, this county remains now as timberless as it is waterless.

ITS LOW MINERAL STATUS.

San Francisco, being a county of small proportions, and withal far outside the great mineral belt that has made California famous, little can be said about her mineral resources, which are, in fact, very restricted, both as regards variety and economic value. A number of small auriferous veins have been found in the county, the most of them located in the vicinity of the city. The ore thus far obtained from these veins has been scanty and of low grade. None of them have as yet been developed to a paying point, though many efforts have been made to that end, some of them too persistently kept up for the financial good of those engaged in them. On the ocean beach gold-bearing black sand occurs in considerable quantity. Attempts have also been made to work these deposits; but these efforts proved so little remunerative that they were soon given up. Some of the hills in the southern part of the city consist largely of a coarse species of red jasper. This material, owing to the facility with which it can be obtained, has been extensively used for macadamizng the streets and similar purposes. The foregoing, with an abundance of clay suitable for making the more common kinds of bricks, comprise, so far as known, the sum total of the mineral resources of this, the most wealthy, but least extensive, county in the State.

SAN LUIS OBISPO COUNTY.

This county derives its name from the mission which, in 1772, was established within its limits. Its boundaries are as follows: Monterey County on the north, Kern on the northeast and east, Santa Barbara and Ventura on the south, and the Pacific Ocean on the southwest and west.

The Santa Lucia Mountains, being the westerly lying ridge of the Coast Range, strike northwest and southeast across the entire length of this county, the other branch of the Coast Range, though more broken, occupying its easterly portion. Between these mountain ranges, and flanking them on the east and west, occur many valleys and much low hill land, constituting the principal agricultural districts of the county. Wild oats and the native grasses grow abundantly all over this county, making it one of the best grazing regions in the State. As a consequence, large numbers of cattle and sheep, the most of them improved breeds, are pastured here.

The cereal crops and fruits of most kinds are also largely produced, both the soil and the climate being highly favorable to their growth.

The county is watered by the upper tributaries of the Salinas River, flowing north; San Simi Creek, running southwest and emptying into San Luis Bay, and by the Cuyama River, flowing across its southern border, and forming in part the dividing line between this and Santa Barbara Counties. The timber here chiefly consists of oak, madrona, and manzanita, with a little scrubby pine on the mountains.

MINERAL RESOURCES.

Gold, silver, lead, copper, quicksilver, chromite, gypsum, onyx, silica, salt, lime, coal, and petroleum have been found in the mountains of this county. Some of these have been discovered in sufficient quantities to pay for working, and it is quite likely that a careful investigation of the remote mountain regions would result in additions to the mineral resources. Although the limited time at our disposal prevented a systematic examination of the county, through the courtesy of Mr. Wm. Angel, the historian of San Luis Obispo, we have been able to gather many facts of public interest that have not as yet come under our personal observation.

GOLD.

It is a matter of history that gold was shipped from San Luis Obispo and neighboring counties prior to its discovery by Marshall in 1848. The explorers of the Pacific Railroad reported gold west of Salinas in 1854, though its existence in the San José Mountains had long been known. Gold has been and is still washed from sands in the bed of the San Marcos Creek, about four miles northwest of Paso Robles, during the wet months of the year, yielding, it is said, as high as from $3 to $4 per man per day. Placer claims have also been worked thirty miles southeast of Templeton since 1870–1871, ground sluicing and panning, when water has been plentiful, having yielded from $2 to $4 per day.

The placer mines of the La Panza District are the best known, and are probably of the most importance. They are situated at the southeastern foot of the San José Range, which rises as a formidable mountain joining the Santa Lucia, and over $100,000 in gold have been taken out. During 1878 there was quite a rush to these parts, and prospecting was carried on in nearly all the gulches leading from the San José Range to the San Juan River. The chief interest was centered in the De la Guerra Gulch, where the most mining was done—even as late as 1882; also upon the Navajo Creek, which is a stream of constantly flowing water. Some of these placers have yielded as high as $4 per day. The gold was coarse, pieces worth 50 cents or 80 cents being of frequent occurrence. Haystack Cañon also has running water and gold. Near the head of this cañon are falls of twenty feet, where the water descends into a basin nearly twenty feet across and ten or twelve feet deep.

These streams reach the channel of the San Juan during very wet weather. Of late years these mines have not been actively worked, chiefly on account of the scarcity of water. In the southern portion of the county, gold has also been found in sands on the seashore in considerable quantity. They are reported as yielding from $1 50 to $2 per day to the miner, and, as the gold dust appears to be renewed by the washing of the sea, the deposits are practically inexhaustible.

SILVER.

San Luis Obispo, in common with all of the Californian Missions, hold to the customary legends of rich silver mines having been formerly worked within its borders by the Indians and old Spanish "padres."

COPPER.

In 1862, during the great copper excitement, several copper mines were opened in the northwestern part of the county. Green Elephant and North Mexican were amongst the most promising. In 1863, copper was obtained and smelted in the neighborhood of the above mines, and shipped to San Francisco. Sulphurets, carbonate, and silicate ores are widely distributed throughout the county, the float rock being often very rich. Cubanite, a sulphide of copper and iron, is said to exist abundantly upon Santa Rosa Creek.

QUICKSILVER

Was discovered in 1872 by a Mexican, in the mountains west of San Simeon, although it was long known to exist in the county by the Indians, who used it as a paint, and were in the habit of visiting the Santa Lucia Range of mountains to procure it for that purpose. Over one hundred and fifty quicksilver claims are recorded in the San Simeon District. In 1871 discoveries of cinnabar were made at Cambria; also about eight miles north of the first discovery, near the northeast corner of the Piedra Blanca Rancho, which led to the discovery of the Pire Mountain lode, on the summit of the Santa Lucia. On this lode eight claims were located, from which a large quantity of ore, stated to average 2½ per cent, has been extracted. The Gibson and Phillips claims, the Santa Maria, Buckeye, and Jeff Davis are all located on the same lode. The San José Mines were located in 1872 upon the eastern slope of the Santa Lucia Range. The principal mine that has been developed is the Oceanic. The original claims, three in number, were located in 1874, and are situated on the north side and three quarters of a mile from the Santa Rosa Creek, and five miles from Cambria. The ledge runs east and west, dipping to the north at an angle of about 17 degrees; the vein is said to vary from eight feet to thirty-two feet in width. At times over three hundred men were employed in these works. Three furnaces were erected at a cost of $90,000. Good returns were made on the capital while the price of quicksilver was high, but when it fell to 40 cents per pound it was found impossible to produce it at a profit, and work was suspended.

CHROMITE.

Large deposits of chromite exist in various parts of the county, but mining has been principally carried on in the Santa Lucia and Buchon Ranges.

RACKLIFF'S MINE.

This mine is situated five miles northwest of the county seat; is leased to Wm. Copeland & Company. Developments have been carried on here to a limited extent during the past year, and between one hundred and two hundred tons of the chromite were shipped to San Francisco; price obtained per ton at San Luis Obispo, $9. The San Juan, Castro, Primera, El Satto, and El Devisadero, which are all situated northeast of San Luis Obispo, are the property of Goldtree Brothers. These mines have not been

worked during the current year, there being sufficient chromite already on the dump to supply the demand. The price obtained is $8 50 per ton at San Luis Obispo. The principal shipments have been to Germany. William Goldtree states that it would not pay to work these mines unless $12 per ton could be obtained for their average product. The mines are patented. G. Jasper is working a mine, seven or eight miles distant from San Luis Obispo, and he ships about one hundred and fifty tons per year to Baltimore. The price obtained is about $8 per ton. It is the opinion of those conversant with chromic mining in the county, that a miner could only make wages by working his own mines at such a figure.

ELECTRO-SILICON.

Several deposits of this mineral occur in the county, particularly in the vicinity of the Bay of San Luis Obispo and San Carpojoro. The deposits at the latter place have so far proved of the greatest value, great quantities having been shipped for polishing purposes.

SALT.

The name Salinas was given to the principal river of San Luis Obispo and Monterey Counties because of the saline springs along its banks and tributaries. In the mountains, about the river's headwaters, are many salt springs of the strongest brine, and large deposits of rock salt. Black Lake is a small sheet of water, half a mile in diameter and of irregular contour, situated near the summit of the San José Mountains, and is so intensely salt as to form a brine suitable for the preservation of meat without further concentration. The salt deposits of the Carrisa Plain appear like the bed of a dry lake, being five miles in length and from half a mile to two miles in breadth. The salt covers the bed to a depth of from six inches to two feet, and is sufficiently pure to be used for many purposes. It is much used for stock, being hauled away in wagons to the ranches, twenty or more miles distant. Water intensely salt is found at a depth of two or three feet beneath the surface in the vicinity of this deposit.

LIME.

Limestone is found in many localities in this county. In the vicinity of Nipono Rancho is a large body of soft marly limestone, that produces a fair article of lime. A good supply of limestone suitable for lime is now being obtained in Lopez Cañon, about eight miles east of the town of Arroyo Grande, and lime burning has been commenced there with a good prospect of success. The immense bed of fossil clams and oysters, near the Oceanic Mine, and on the Santa Margarita Rancho, and the huge *ostrea titans* occurring in several places, when burnt, yielded a fair article of lime, which has been used extensively in retorting at the quicksilver mines in this county.

GYPSUM

Is found at the headwaters of Arroyo Grande and on the Navajo Creek.

COAL

Was discovered in this county as early as 1863 on the beach at San Simeon by Wm. Leffingwell, who used it for blacksmithing. The San

Simeon Coal Mining Company was subsequently started by C. B. Rutherford, of Oakland. This is said to have been the first mining company started in the county. The outcrop of the vein was two feet in width, and usually covered with water at high tide. A shaft was sunk to a depth of about one hundred feet, at which point the vein dwindles to a mere seam, and mining was abandoned. Coal has also been found in the mountains east of the town of San Luis Obispo, but not in sufficient quantities to pay for working.

THE BITUMINOUS DEPOSITS

Of this county were exhaustively treated in the seventh annual report. The principal mine is near the road running from Steel Railroad Station to the coast. From this deposit about thirteen thousand tons were shipped during the year ending July, 1888.

BUILDING STONE.

There are several varieties of building stone in the county. The range of peaks which extend from San Luis Peak to Moro Rock are composed of trachytic porphyry, which is used locally, and of late there has been some talk of establishing a quarry either at Moro Rock or some of the neighboring peaks. A sandstone crops out also a half mile southeast of Arroyo Grande, and extends to Los Varos Creek. At the latter place a quarry has been opened by Hugill Bros. About fifty feet of rock are here exposed, which is a light buff-colored sandstone, soft when quarried, and can be sawn into cubes, but becomes hard upon exposure to the atmosphere. This stone has been much used for chimneys and foundations in the vicinity. A quarry of similar rock is said to have been opened by J. S. Rice five miles from Pismo wharf.

SAN MATEO COUNTY.

This county is named after the apostle Saint Matthew, and occupies nearly the entire peninsula which separates San Francisco Bay from the Pacific Ocean. San Mateo is bounded on the north by the County and Bay of San Francisco, on the east by a continuation of San Francisco Bay and the County of Santa Clara, on the south by Santa Cruz, and on the west by the Pacific Ocean.

The Sierra Moreno, the northern portion of the Santa Cruz Mountains, traverses this county throughout its entire length. The trend of these mountains is parallel to the seashore, and they have an average height of one thousand five hundred feet, reaching at some points to twice that altitude. Their precipitous sides are in many places broken by deep cañons, down which water flows the year round. It is from springs and lakes in these mountains that the City of San Francisco derives her principal water supply. The southerly half of the Sierra Moreno is timbered with redwood, oak, and manzanita. Upon the seacoast and along the shore of San Francisco Bay is a strip of level farming country, the greater portion of which is covered by a rich alluvium, the soil of the entire county being exceedingly fertile. San Mateo is preëminently a dairy county; it is close to the best market in the State, is well watered and covered with a nutritious herbage, the native growth being supplemented in many instances with cultivated grasses.

The minerals of this county, as far as investigation has shown, consist of gold, silver, petroleum, coal, quicksilver, lime, and building stones. Of these, petroleum and building stones are at present alone turned to any practical account.

GOLD AND SILVER.

Traces of gold have been discovered in various creeks and gulches in San Mateo County, especially on the Hawes Ranch, near Redwood City, prospects there having been struck which yielded several colors of gold to the pan. There is said to be a quartz ledge on Deniston Peak which assays a few dollars to the ton, and from which specimens showing free gold have been obtained. Also upon the ranch of Ote Durham, on the Tanitas Creek, is a ledge of quartz which is said to assay well, both in gold and silver.

Placer mining has, at intervals, been carried on at several points along the seashore with varied success. A bed of black sand on the beach at the Deniston Ranch, about one mile north of Amesport Landing, was worked with only partial success, though one of the parties states that he recovered about $7 to the ton.

PETROLEUM.

Petroleum occurs at several points in the county, which have been described in the seventh annual report. New wells are being bored near Purissima Creek. At some places a fair showing of oil was obtained.

INFLAMMABLE GAS.

A gas well is now being bored on the Hazelwood Ranch, the property of S. L. Jones. In a cañon on this ranch are three mineral springs, in the central one of which inflammable gas was discovered two years ago. At a depth of one hundred and one feet a volume of gas was struck which bubbled freely from the surface of the water in the boring. Mr. Jones intends sinking this well to the depth of one thousand feet. The formation in the neighborhood of the well is shale, with an occasional strata of sandstone. The dip is to the south at an angle of about 45 degrees. The surface of the ground is, in many places, covered with calcareous tufa, deposited by superficial springs, which no doubt flow from a limestone formation further back in the hills. The altitude at the well is about one thousand feet above the level of the sea.

LIMESTONE

Is found six miles from San Mateo, on the ranch of the Spring Valley Water Company, at the headwaters of San Mateo Creek, where lime was formerly burned.

BUILDING STONE.

Sandstone is quarried on the Brittan Ranch, about one and one quarter miles southwest of Redwood City. This has been used in the construction of the railroad depot at San Carlos and for other local purposes. A light-colored sandstone crops out about two and a half miles north of Halfmoon Bay, which has been used in the library building at San Mateo, also for foundations at Halfmoon Bay. It is a fair quarry of freestone; the formation dips a trifle east of south at an angle of about 50 degrees. A quarry of metamorphosed sandstone is now opened on the land of O. E. Brady, at Coleman. The rock is a metamorphosed sandstone and varies

from a yellowish brown to a gray and a bluish color, and appears to be an excellent building material. The Crocker building, on California and Jones Streets, San Francisco, and the Starr King church, on Franklin and Geary Streets, are built of this material. The formation in this quarry is much disturbed, both the angle and the direction of the pitch varying greatly in different parts of the quarry. About one hundred feet of rock have been exposed by quarrying. Blocks four by four by two feet, and slabs seven feet by fourteen inches by ten inches, are here readily obtainable. Some blocks over eight tons in weight when dressed have been taken out. This stone splits readily in any direction and is smooth working.

SPRING VALLEY WATER COMPANY.

A rock much resembling the bluish variety of the Coleman sandstone is being used by the Spring Valley Water Company in the dam they are constructing about five miles west of San Mateo. This company has dammed the San Mateo Creek in order to form a lake of the Cañada Raymundo Valley, which extends for a distance of nine miles, and lies between the eastern water-shed of the San Mateo portion of the Coast Range and the western water-shed of a spur of hills which starts from the main range at Woodside, running thence in a northerly direction. By the construction of this dam the Cañada Raymundo Valley will, in course of time, be converted into a great storage lake, having a capacity of upwards of thirty thousand million gallons of water. As is well known, the present water supply of San Francisco is derived chiefly from the Pilarcitos, the San Andreas, and Upper Crystal Springs Lakes, the water from which is conveyed by pipes a distance of twelve miles to the city. It is also the intention of the Spring Valley Water Company to connect the San Francisquito Creek with the before mentioned large storage lake, by means of a tunnel extending therefrom to the village of Searsville, where another dam is to be built for the purpose of making a second storage reservoir to receive all excess of water during times of great rainfall.

The rock used in the first mentioned dam now under construction is a bluish metamorphosed sandstone and is quarried from the immediate vicinity. The formation in the neighborhood of the dam is composed of metamorphosed sandstones and shales, between which small veins of clay and coal have been found, the latter mineral having at times shown a width of two feet, although it has mostly appeared as a thin seam, broken and mixed with clay. The dam when finished will be about one hundred and seventy feet high, one hundred and seventy-two feet wide at the base, tapering to a width of twenty-five feet at the top, and having a water-slope of one vertical to four horizontal feet. The material of which it is being built is concrete formed of one barrel of Portland cement, two of sand, and six of rock. All shale rock is carefully sorted out and the sandstone is passed through nine Wheeler crushers, each of which has a capacity of eighty cubic yards, or one hundred and twenty-five tons of rock per ten hours. From the crushers it is discharged into rotary, perforated cylinders fourteen feet long and four feet in diameter, where all dust caused by the crushing or any clayey matter that may be adhering to the rock is washed from it. The size of the crushed rock varies from that of a hen's egg to that of a hazelnut. From the rotary cylinders it is conveyed to the mixers, which are rotary cubes of wrought iron, to each of which a shaft is diagonally attached. Each of these cubes is charged with one barrel of Portland cement, two barrels of sand, and six barrels of rock, equal to twenty-four cubic feet of concrete when set. From twelve to sixteen gal-

lons of water are added, and the cubes, on revolving, effectually mix the compound. From the cubes it is emptied into cars, in which it is run over a trestle one hundred and twenty feet high to ten chutes, which discharge it upon the working platform, which is at a level with the top of the dam; along which the concrete is wheeled to a "pit." The "pit" is a bin corresponding to the size of the block of concrete about to be made. These blocks are thirty by forty by eight feet. Two of them are made each day and placed alternately in the horizontal section of the dam, a space the size of a block intervening. After the alternate blocks have become set the intervening space is filled. The concrete is dumped in layers of three or four inches, and is tamped with rammers of five-pound weight.

Before a fresh block is commenced, the top of the one upon which it is to stand is carefully washed. To guard against leakage cuts extend through the dam into the hills upon each side for a distance of thirty feet, which are filled with concrete. In order to make a foundation for the dam an excavation to a depth of eight feet in the solid rock was made, and for the cuts twenty feet. To test the ground upon which the dam is built, an eight-inch hole was bored to the depth of eighty feet in solid rock a short distance away on what will be the water side of the dam, and no seepage was noticed. No blasting is allowed around the construction works. The dam is now—September 13, 1888—ninety feet high and eighty feet wide. Five hundred men are employed on the works, also one hundred teams. The sand used is brought from North Beach, San Francisco.

SANTA BARBARA COUNTY.

This county is named after the Mission established in 1786, on the spot where the City of Santa Barbara now stands. It is bounded on the north by San Luis Obispo, on the east by Ventura, on the south by Santa Barbara Channel, and on the west by the Pacific Ocean.

Much of Santa Barbara County is hilly or mountainous; the Santa Inez, a low range of mountains, follows the trend of the coast across the southern part of the county; and the Sierra de San Rafael, a higher range, strikes through the center of the county and extends almost to its northern limits. These mountains, with their foothills and spurs, impart to the whole county a rugged and diversified aspect. The Santa Inez River, flowing west, traverses the entire length of the county; this river, with the Jesus Maria and the Cuyama, constitute the only large streams in the county; there are many mountain rivulets tributary to these larger streams. Santa Barbara County contains many fertile valleys well adapted for growing the cereal crops, but the greater part of the territory is better suited for the cultivation of fruit and cattle raising. The choicest fruits and grapes are produced here, and the whole county, even to the tops of the mountains, is covered with indigenous grasses, which supply food for a great number of cattle and sheep all the year round. At Point Concepcion, which forms the southwestern angle of the county, the coast line deflects sharply to the east, and it maintains this direction along almost the entire length of the county. The timber lands here are chiefly confined to the Sierra de San Rafael; in other parts of the county the timber is both scattered and scanty, being principally confined to park-like growths of oak and some sycamore along the watercourses. In the eastern part of the county, on the slopes of Mount Pinos, some pine and redwood are found. This mountain, which stands at the junction of the Sierra Nevada and the

Coast Range, reaches an elevation of nearly seven thousand five hundred feet.

GOLD.

On the San Marcos Ranch there is said to be a lode that assays well in both gold and silver. Gold-bearing rock has also been found on the Buel Ranch near Los Alamos. Placer claims have been worked at Pine Mountain, also at the headwaters of Zaca Creek, and at several places in the San Rafael Mountains. A few colors of gold are occasionally found in the creeks running from the Santa Inez Range. Gold washing has also been carried on upon the seashore; the most successful operations were at Point Sal, in the northwestern corner of the county. Point Sal is situated upon the southern bank of the Santa Maria River. Gold washing has been intermittingly carried on here by the Point Sal Mining Company. The gold is found in streaks of black sand from three to four feet below the surface of the beach. They run from one inch to two feet in thickness, usually being about one foot, and from thirty to forty feet in length. The bank of the beach runs north and south, the streaks of sand east and west toward the ocean. Beneath the black sand is blue clay in some places and sandstone in others. The richest deposits are found on the sandstone where it is worn into ridges, being favorable to the concentration of the gold. This sand is run into a hopper, where a stream of water carried it over amalgamated plates. About twenty-five tons of this sand yielded $137.

On the Jonita Ranch, near Los Alamos, rock containing gold and silver has been found. This at last induced Wm. Buel to explore the formation of his ranch, by running a tunnel of about four hundred feet. This tunnel, which is situated a little over one thousand feet above the sea, is run in a southwesterly direction through a sedimentary formation, which dips to the south at an angle of about 45 degrees. The tunnel commences in a light-colored slate, which passes into a darker-colored and more argillaceous rock, sometimes containing small veins of gypsum. Further on the tunnel penetrated a darker-colored slate of more perfect cleavage, which towards the end of the tunnel is hard and siliceous, breaking with a conchoidal fracture. Here and there throughout the tunnel are a few seams and pockets of clayey matter, which are said to show a few colors of gold. The tunnel does not appear to be following any vein. The formation appears to be the upper strata of the bituminous slates which crop out on other portions of the ranch, although the rocks actually penetrated by the tunnel do not appear to contain bituminous matter that can be detected by a physical examination. It would be a remarkable thing if such rocks were found to contain gold in paying quantities.

COPPER

Is said to exist in paying quantities on the southern bank of the Santa Cruz River, where it was worked by the old "padres;" also, at several places in the San Rafael Mountains.

QUICKSILVER

Is said to exist at Los Brietos, nine miles north of Santa Barbara, on the upper waters of the Santa Inez River, in considerable quantities. It is claimed that a great deal of the ore will average from 2 to 3 per cent. The Eagle Quicksilver Mine was also worked in 1867, by Captain Samuel Stanton, on the Cuchamma River, in the San Rafael Mountains.

PETROLEUM, BITUMINOUS ROCK, AND INFLAMMABLE GAS

Were fully described in the seventh annual report of the State Mineralogist.

COAL

Has been found at several places in Santa Barbara County, notably in the Loma Paloma, head of Santa Inez Creek, Montecito Hot Springs, and at the Mission.

LEAD.

Float rock containing galena is said to be found at the mouth of Dry Creek Cañon, on the Buel Ranch, near Los Alamos; also, on the Spinnocia Ranch, about twelve miles east of Santa Inez, in the San Rafael Mountains.

MANGANESE

Occurs in the San Rafael Mountains, about seven miles north of the town of Santa Inez.

LIMESTONE

Is widely distributed in the county, but as yet has been burnt only for local use. It is found upon Moore's Ranch, a few miles west of Santa Barbara. Immediately north of Mr. Moore's house, distant about two miles from the seashore, are the foothills of the Santa Inez Range, spurs from which run down nearly to the water's edge; these are composed of sandstone, varying from coarse to fine. At one point they are traversed by a vein of calcite about four feet wide, running nearly east and west.

GYPSUM.

The gypsum deposits of Santa Barbara occur upon the southern side of Point Sal, and can be reached by road either from Guadalupe or Santa Maria. Point Sal Gypsum Mines lie back in the mountains about one and one half miles from Point Sal Landing. They occur as a vein having a head-wall and foot-wall of clay slate. There are six openings on this property from which gypsum is taken. There are two lower workings, one a tunnel about forty feet in length, and upon the opposite side of the ravine another of perhaps three hundred feet. In both these tunnels the vein dips to a little west of north, at an angle of about 55 degrees. About a quarter of a mile up the mountain is another working; here the vein dips only at an angle of about 15 degrees. The finest quality of the material is said to be obtained in the upper workings. The other openings are of less importance, and no gypsum is at present being taken from them. The lower vein can be traced for about two miles. This mineral can be mined and placed on board the vessels at Point Sal for about $2 per ton. From the mouth of the cañon in which these deposits are situated, the road leaves the coast line. The hills to the north are of sandstone and argillaceous rock, the former containing the bones of marine animals; in places they are also highly impregnated with petroleum. Southward the rock continues over a series of sand dunes, capped by protrusions of clayey and possibly infusorial rock. This is cut into at many places by the roadway, and at some points appears to be several hundred feet in thickness.

From Lompoc, the road southward crosses the San Julian Grant. A short distance past the ranch house, the sandstone crops out in several

places, and fragments of agatized rocks by the wayside would seem to indicate metamorphism in the higher portions of the Santa Inez Mountains. Between Las Cruces and Gaviota Pass, sandstone is again encountered. The Gaviota Pass is not much more than one hundred feet wide at its narrowest point. The stream flowing through the cañon is crossed by a bridge, the abutments of which are built of sandstone from the immediate locality. The "rip-rapping," which forms the approaches of the bridge, is also built of the same material. Near the bridge the formation is coated with calcareous tufa, probably resulting from the seepage of water from calcareous rocks higher up the mountain. Some of the sandstone in this locality is an excellent building material. The general dip of the formation is to the south, at an angle of about 50 degrees, although the transverse fracture of the strata in several places would lead one to suppose otherwise.

One of the first rocks that arrest the attention is a compact hard limestone, containing much sand, tiny pebbles, and broken shells. This stratum is probably from fifty to a hundred feet in thickness. To the north of the pass, upon the east side of the stream, several ledges of close-grained brown sandstone crop out, which are well adapted to building purposes. The outcrop upon the west side of the roadway is buried beneath the sandstone blocks, varying in size from a few to many feet in diameter, which have fallen from the formation above. The bowlders in the stream afford a good idea of the varieties of sandstone belonging to the overlying formations. They differ both in texture and color, but nearly all appear to be good building rock, their weathered surfaces being hard and compact and almost free from stains of oxide of iron. The color of the greater portion of the sandstone at Gaviota is light brown, or buff, and the formation must be several hundred feet in thickness.

At the south end of the bridge is a gray sandstone, which appears to split very easily, although by no means as strong and durable a rock as the light brown to the north of the bridge. It is from this rock that the stone work of the bridge is principally made. Of all the rocks in the creek bed which have best withstood the action of the water and weather, the compact calcareous rock first mentioned ranks the highest.

Further toward the sea the sandstone becomes weaker and more friable, passing into a formation of shales interstratified with several courses of cherty limestone, which extends nearly to the seashore. The trend of the coast line here is east and west, and the roadway, which lies at the base of the Santa Inez Mountains, skirts the seashore. The principal rocks outcropping along its course are light-colored calcareous slates or shales, which appear to be dipping toward the south at an angle of from 40 degrees to 50 degrees. A notable exception, however, occurs about twelve miles east from Gaviota, at the Moore Rancho. Here the rocks on the seashore dip only at an angle of from 15 degrees to 20 degrees.

At a distance of two hundred yards from the seashore, a white, compact, magnesian limestone crops out, which seems well adapted for building purposes. It occurs in ledges about six feet in thickness, which dip to the south at an angle of some 20 degrees. Little or no quarrying has yet been done upon it. It may show a much greater thickness of strata when opened, for the erosion upon the southern extremity of the formation has evidently been great. This stone, although varying slightly both in color and texture, can be traced for a distance of about four miles in an eastern and western direction, and north for perhaps half a mile. Toward its northern extremity the angle of the dip increases to about 50 degrees. The fracture of this rock is smooth and even, and the few slabs that have

been quarried ring when struck by the hammer, the weathered surfaces in most instances presenting no discoloration. Further to the east this rock is of a light-yellow color, and dips a little to the east of south at an angle of about 15 degrees. Toward the seashore the formation is a light-colored calcareous shale, dipping a little west of south, at an angle of about 26 degrees. Upon the western side of the Tajiguas Creek this shale becomes sandy and less fissile, and overlies a stratum of limestone about two feet in thickness, beneath which bituminous shale crops out. Should the building stone ever be utilized, the slope of the hill, which cannot be more than fifteen feet to the one hundred, will be found a great advantage in handling the rock.

MINERAL SPRINGS.

There are several mineral springs in this county, but few of them have as yet become places of resort. At Montecito the water from the springs reaches 117 degrees Fahrenheit. On the Santa Inez Mountains, near Santa Barbara, there is another hot spring; also in the San Marcos Cañon, where the water is said to reach a temperature of 120 degrees Fahrenheit. In the cañon and the Cuyama Valley are also springs.

SANTA CLARA COUNTY.

This county obtains its name from the mission founded in 1777, and which with the college now connected with it, still exists, standing within the confines of the present beautiful and prosperous City of Santa Clara. The county is bounded on the north by Alameda, on the east by Stanislaus and Merced, on the south by San Benito and Santa Cruz, and on the west by Santa Cruz and San Mateo.

The characteristic topographical features of this county consist of a broad central valley inclosed by the two parallel ridges of the Coast Range, one on the east and the other on the west, the latter separating it from the sea and the former from the great valley of the San Joaquin. While the more westerly of these ridges is well timbered with pine, oak, and redwood, the more easterly contains only a scattered growth of oak, which is also the condition of the main valley, comprising nearly one half of the entire county.

In the eastern ridge of the Coast Range is Mount Hamilton, the site of the Lick Observatory. This mountain, in the former geographical nomenclature of the country called Santa Isabel, consists of a group of peaks and high knolls, to each of which the name of some distinguished astronomer has been given, the elevation on which the principal edifice stands being called Observatory Peak. It has an altitude of four thousand three hundred and two feet.

While Santa Clara is fairly timbered, it is but poorly watered, as regards running streams, of which there are only two of any size—Los Gatos and Coyote Creeks. Abundance of water is, however, easily obtained in the valley by artesian boring.

Every agricultural staple produced in California, grapes, and fruits of all kinds, are largely and profitably raised in this county. The principal mineral products are quicksilver, building stone, lime, bituminous rock, and petroleum. Although other useful minerals are to be found, they are not at present turned to any practical account. Of the mountain districts

in the county, many have never been thoroughly prospected, especially the territory to the north and northeast of Mount Hamilton.

THE NEW ALMADEN QUICKSILVER MINES.

The quicksilver interests of Santa Clara County are at present centered in the New Almaden Mines. These mines are situated near the western limits of the county, in a cañon of the inner Coast Range, twelve miles southwest of San José. Millions of dollars have been expended here, and many more millions of dollars worth of quicksilver have been taken out in return; the total yield of this metal for the last quarter of a century being seventy million pounds. The first discovery of quicksilver on this coast was made at Almaden. The natives had used the red ore for paint, but without any knowledge of its mineral character.

The ore is brought from the mines to the reduction works in cars run by gravity pulleys, and is dumped into chutes, where screens set at an angle of 45 degrees separate it into three sizes—the granza, coarse ore; the granzita, medium-sized, and the tierras, fine ore. The latter grade was formerly made into bricks and treated in an intermittent furnace, together with coarse ore. A great economy is now effected by working the fine ore alone, in the tierras furnaces. Such ore as needs drying is dried either by spreading out and exposing to the sun, or in an upright chamber, heated by the vapors and hot air passing from the tierras furnace. The dry ore is discharged at the bottom of the drying chamber, and is elevated to the charging floor by means of a water hoist, a tank of water being made to balance a car full of ore.

The Tierras Furnace.

The dry ore is run by trucks from the elevator to the top of the furnace, where it is dumped into a hopper, the throat of which closes with a slide-valve, which sustains the charge of the ore hopper until needed, and shuts off any vapors which might otherwise escape from the heated ore below. When this slide-valve is opened, a charge of ore drops into the throat of the furnace, which, when filled with ore, naturally assists in keeping down the vapors. From here the ore falls upon a series of tiles, set one above another in the brickwork of the furnace, each one inclined toward the one below at an angle of about 45 degrees. Each hopper feeds two sets of such tiles, and each furnace is partitioned off into three compartments.

The firing floor is about twelve feet below the charging floor. Here a fireplace runs across one side of the furnace, being fed at both ends with four-foot sticks of oak, pine, or redwood. The flame reverberates on the arched roof of the fireplace, and passes through holes in a wall, which divides the fireplace from the main body of the furnace. Crossing the ore-laden tiles to the opposite side, the flame enters a chamber, the arched roof of which again causes it to reverberate across the furnace. This reverberating process is repeated a third time. Each reverberation heats a separate tier of ore-laden tiles. The vaporous product of the furnace passes by means of an air pipe through the hollow walls of the drier into the condenser. Each double set of inclined tiles terminates in "boshes," in which the roasted ore collects, which is finally discharged from three openings, regulated by a shaking table at the bottom of the furnace. There are four of these tierras furnaces at the New Almaden Reduction Works, which vary in capacity as follows: One is charged with seventy-two thousand pounds of ore every twenty-four hours; two each receive forty-eight

thousand pounds during the same time; and one twenty-four thousand pounds.

The Granzita Furnace.

This furnace resembles the tierras furnace, except that the tiles are a little further apart and there is no shaking table at the base. The cool roasted ore is raked out from the places of discharge at the bottom of the furnace. There are two granzita furnaces at the New Almaden works, one having a capacity of seventy-two thousand pounds in twenty-four hours, and the other thirty-six thousand pounds.

The Granza Furnace.

The hopper of this furnace, which protrudes above the charging floor, is covered with a lid closing with a water-tight joint, the rim of this lid being submerged in a circular trough surrounding the hopper, to prevent the escape of vapors. Through this lid passes a rod connected with a plug, so fitted to the bottom of the hopper that by depressing the rod the plug is lowered, and the contents of the hopper emptied, and by elevating the rod it is tightly closed. This furnace is charged by lifting the air-tight cover and dumping one thousand six hundred pounds of ore into the hopper. The cover is then let down, the plug at the bottom of the hopper lowered, and the charge admitted into the furnace. The body of the furnace is modeled after the cupola. Below the charging floor the furnace is encircled by a pipe, with which smaller pipes, or delivery tubes, leading from inside are connected. The mercurial vapors ascend in the furnace and though the delivery tubes to the outside conducting pipes, and thence to the condensing chamber. About twenty feet below the piping is the firing floor, where three fireplaces lead into the body of the furnace, and are fed with wood four feet in length. Twelve feet beneath the firing floor is the ground floor and point of discharge; between it and the firing floor the body of the furnace constitutes a cooling chamber for the roasted ore, which is from time to time raked from three points of discharge at the base of the furnace. This furnace, which is principally used for the highest grade ore, has a capacity of nineteen thousand two hundred pounds in twenty-four hours.

The condensing chamber attached to the tierras furnace will serve as a representation of those in use at these works. This chamber is thirty-five feet long, twenty feet high, and twenty feet wide. The interior is cooled by eleven pipes the length of the chamber. Any uncondensed vapors which may pass through the chamber are conducted into a flue where, by the aid of a Guybal fan, they are conveyed a distance up an incline three hundred yards to a brick stack eighty feet high. From this extended flue traces of quicksilver are recovered which would otherwise escape.

THE GUADALUPE QUICKSILVER MINING COMPANY.

The works of this company, which have been shut down for several years on account of litigation, are situated in Alameda Township, about two miles to the north of the Almaden Mines, upon the eastern slope of the mountains. The Guadalupe Mine first became known to the Americans through Mr. Josiah Belden, who, while crossing the mountains with a party in 1846, came upon Indians who were painting themselves with cinnabar which they had procured from the croppings of the ledge. A location was made, and after passing through various preliminary stages and experiences, the property, including a vast body of land, finally settled in the

hands of a corporation known as the Santa Clara Mining Association, of Baltimore, who operated it until litigation closed it down a few years ago.

At the works of this company there are two plain upright furnaces for coarse ore and two fine ore furnaces; the latter were built upon a plan designed by the company after consulting the various models of furnaces then in use.

These works were in active operation from 1883 to 1885, during which time their output was from one thousand two hundred to one thousand five hundred flasks per month.

Cinnabar has been found in several places in the county, but the work of development being so small upon these finds, mention can only be made of them as fair "prospects."

LIMESTONE AND LIME.

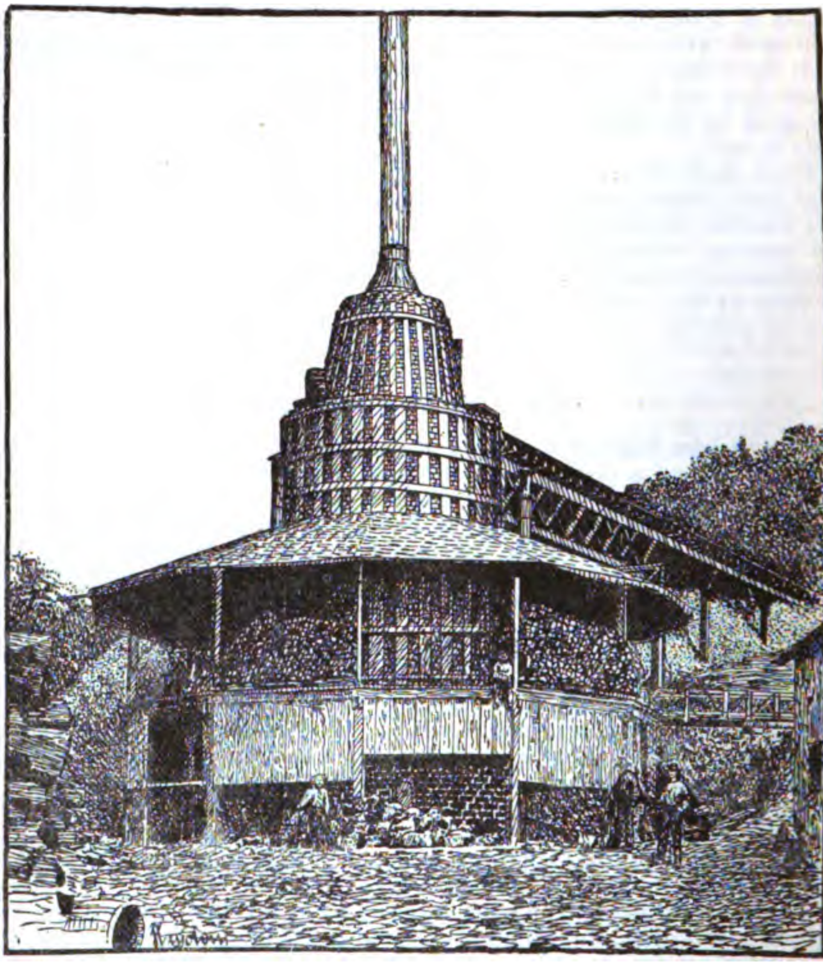
Guadalupe Lime Company.

An extensive business is carried on at these works, the kiln being a perpetual one, and a decided improvement on the old fashioned pot kiln. The works of this company are situated upon the eastern slope of the Almaden section of the Santa Cruz Mountains, about ten miles southwest of San José, and two and one half miles from Guadalupe Station, on the New Almaden Branch of the Narrow Gauge Railroad. This property was first developed about the year 1864, and the lime burned in kilns on the banks of the Guadalupe Creek.

The principal quarry of this company is situated at the height of about nine hundred feet above sea level. It is a circular opening, and was connected by a tunnel with other workings about one hundred and fifty feet below, but the tunnel has now caved in. The limestone in this quarry is about forty-five feet thick, and dips to the southwest at an angle of over 30 degrees. It is a dark-colored bituminous limestone, many samples of which smell strongly of petroleum when freshly broken. Both above and below the limestone are strata of shale.

The present workings appear to be confined to smaller openings, most of which are at a lower elevation. In some of these the limestone is of a light color, but the formation presents the same general characteristics as the former. The lime kiln, which is situated about four hundred feet below the upper quarry, is supplied with limestone by trucks worked by a gravity pulley from the quarries above. The kiln is an upright circular furnace about sixty feet high, tapering from a circumference of about one hundred feet at the base, to about forty at the top; it is surmounted by a smokestack sixty feet in height. This kiln is connected with an outer wall of ordinary brick. and an inner one of firebrick, the space intervening being filled with concrete; altogether forming a wall of about six feet thick.

The trucks from the quarry are lowered to the charging platform, which leads to the door of the furnace. About twenty feet beneath the charging platform, the kiln is surrounded by a firing floor. On a level with this floor are three fireplaces, placed at equal distances in the main body of the kiln. The ash pits beneath the grates of the fireplaces extend directly down through the wall of the kiln, leading separately and directly to the ground or drawing floor, about twenty feet below. The space in the kiln between the level of the fireplaces and the ground floor constitutes a cooling chamber, the lime being drawn from three openings at the bottom of



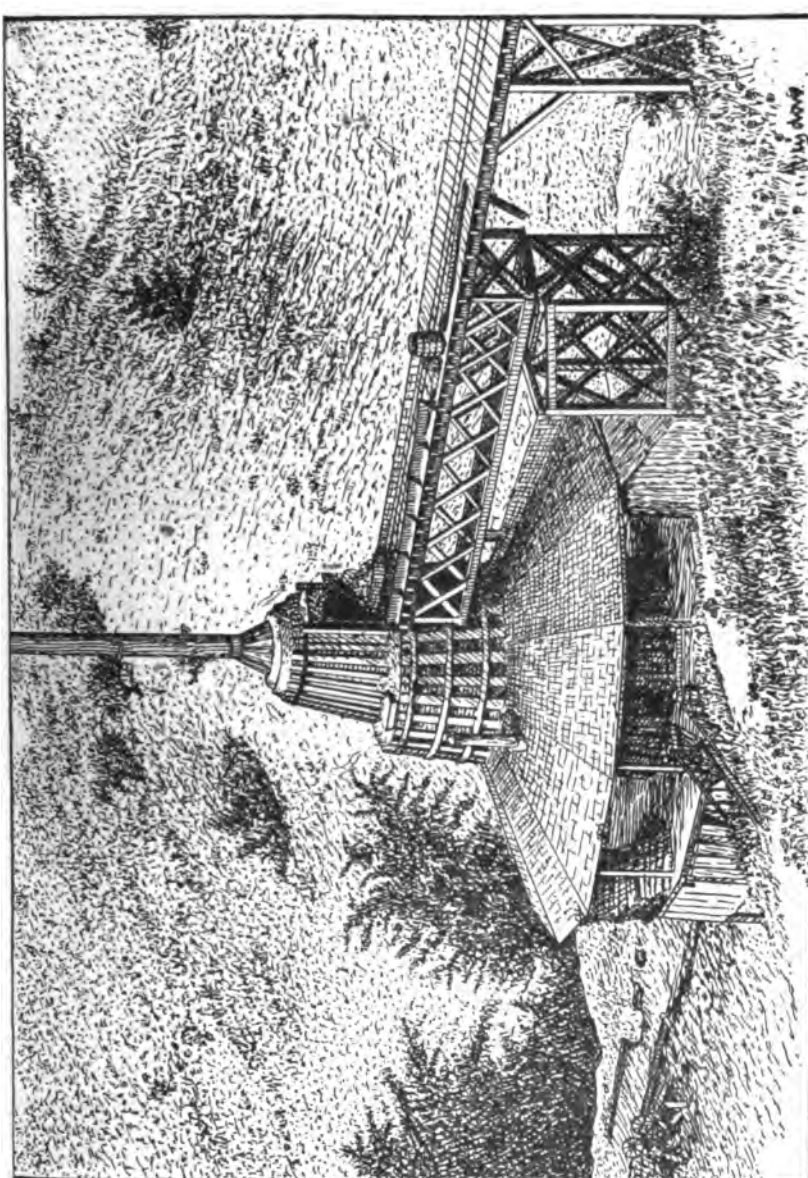
PERPETUAL LIME KILN AT GUADALUPE.

the kiln. This kiln is charged by filling the cooling chamber with waste rock up to the level of the fireplaces, above which eighteen truckloads, equal to about thirty tons, of limestone are dumped. The fires are then lighted, being fed with four-foot sticks of redwood.

After burning three days, a charge equal to twenty-four barrels of waste rock is drawn from the draw-holes at the bottom of the kiln, just as though it were burnt lime, and fresh limestone added at the charging door to keep the charge at the proper height in the kiln. After six drawings, which now take place in twenty-four hours, the waste rock is all drawn out, and the lime begins to make its appearance. The lime is sorted and shoveled into rawhide baskets, and hauled to the depot where it is shipped in bulk. This kiln consumes from four and one half to five cords of wood in twenty-four hours, producing one hundred and sixty barrels of lime in that time.

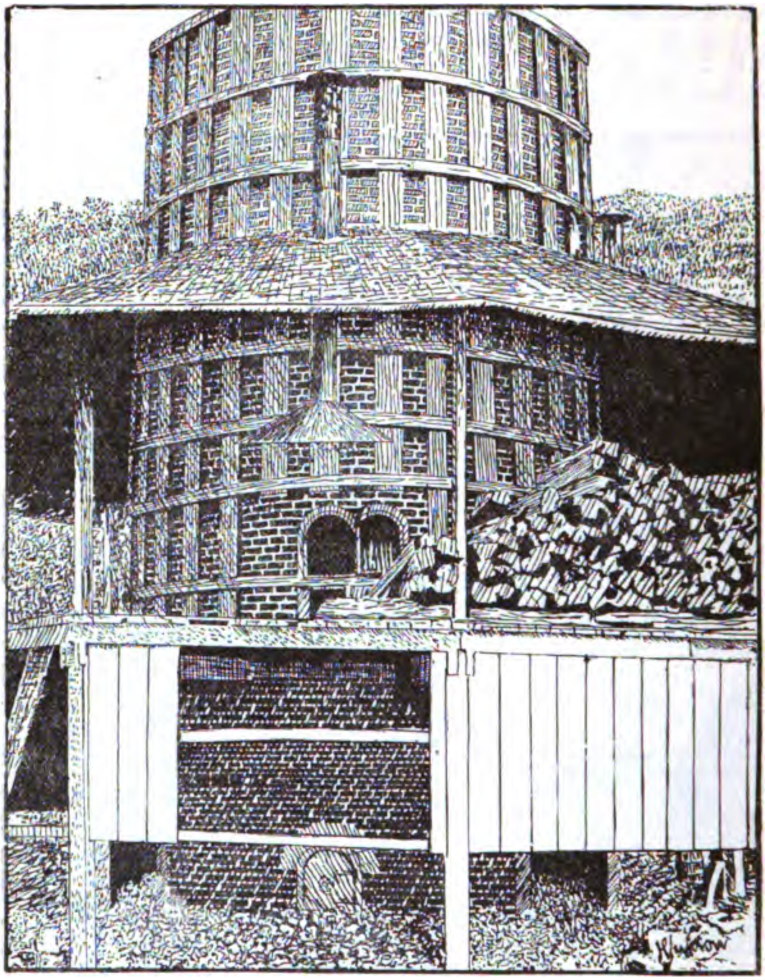
Near Los Gatos an extensive deposit of limestone has been opened on the old Douglas Ranch, now owned by J. E. Ellis, two and one half miles

by road from Los Gatos, and about six hundred feet higher than that place. It is situated in the southwest quarter of the northwest quarter of Sec. 27, T. 8, R. 2 W., M. D. M. At one point about eighteen feet are exposed by quarrying, showing alternate layers of black bituminous limestone inter-



Top of Kiln Showing Charging Platform.

stratified with dark-colored chert, the formation dipping to the west at an angle of about 15 degrees; further up the hill and across the ravine to the west the limestone is of a light color. About nine hundred tons of this



VIEW SHOWING FIRING DOOR AND DISCHARGE DOOR.

limestone were shipped to the Standard Sugar Refinery of Alvarado, in 1886. Shipments were discontinued in consequence of the works shutting down, but operations will be recommenced this year, contracts for over one hundred tons having been made.

BUILDING STONE.

The only quarries that supply anything more than local demand are those situated at and in the vicinity of Graystone, upon the Southern Pacific Railroad. They comprise the Goodrich quarries, eight miles south-southeast of San José, and the Flynn quarry, which is situated in the same range of hills and formation, a mile nearer to San José. All these quarries are located upon the Almaden branch of the Southern Pacific Railroad, which affords excellent facilities for transportation.

The Goodrich Quarry

Is situated in Almaden Township, and belongs to the estate of Levi Goodrich. It has been worked since 1866, and the stone, a light-buff color, has been and is being extensively used in San Francisco. It has been used in the Pioneer building, the Union Club, the Lachman block, as well as in many other buildings, and as copings in the cemeteries. It is from that portion of these quarries, leased to Senator Stanford, that the stone used in the construction of the Stanford University is being obtained. At the southern end of this working the dip is towards the north, at an angle of about 35 degrees. About thirty feet from the lowest point of this inclination, which is near the center of the working, the strata still maintain the same direction, but dip only at an angle of about 15 degrees. Between the two dips the stone is much broken and the strata faulted. The best stone is naturally obtained from that portion where the angle of inclination is the least; in the language of a quarryman "the leveler the bed, the solider the stone." Between the courses of sandstone are layers of clay, being in some places a foot thick, and passing from a tough unctuous clay to a sandy shale. Small round or oval bowlders are occasionally met with from three or four inches to a foot or more in diameter. They occur more frequently in the upper strata of the quarry, and sometimes in the clay or shale between the sandstone, penetrating the underlying and superimposed strata for a few inches. The finest-grained sandstone is obtained in the upper portion of the quarry, the lower being coarser and occasionally interspersed with smaller fragments of clay or shale matter. This stone can be quarried and put on board the cars for 70 cents per cubic foot.

The Stanford Quarry

Is situated about half a mile northwest of that worked by the Goodrich heirs. As already mentioned, the building stone used in the construction of the Stanford University at Mayfield, in this county, is obtained here, about four carloads, or eight hundred cubic feet, of dressed stone being shipped daily for that purpose. About one hundred feet of sandstone have been here exposed by quarrying in strata from two to twenty feet in thickness, dipping to the north at an angle of about 20 degrees.

The Flynn Quarry

Is about one mile to the northwest of the Stanford quarry. The stone of the former is said to be equally good, and facilities for working as great.

PETROLEUM.

The petroleum interests of Santa Clara are situated five miles west of Los Gatos, in the Santa Cruz Mountains, in Moody Gulch, a detailed description of which was given in the seventh annual report of the State Mineralogist. The most important item, when the Moody Gulch was visited this year, was the boring of the Pyler well, which was then about completed. Below will be found a record of the various strata passed through, which has been kindly furnished by the owners.

RECORD OF STRATA PENETRATED BY THE PYLER WELL.

Character of Strata Passed Through.	Depth in Feet.
Yellow decomposed sandstone	33
Blue black sandstone	75
Hard gray sandstone	301
White sand	510
Black	520
Hard white	540
White soft sand	550
Gray sand	560
Shale, sandy, soft	590
Hard gray sand	599
Shale and sand mixed	610
Black sand	640
Sand and slate (mostly slate)	665
Gray sand and tiny quartz pebbles	675
Soft gray sand	680
Shale	745
Shale, salt water, and luminous gas	774
Shale	800
Shale and black sand	840
Black sandy shale	876
Hard, coffee-colored sand	900
Hard, coffee-colored sand	940
Hard, coffee-colored sand	960
Soft sand	970
Shale (caved badly)	985
Shale	986
Shale	996
Black shale	1,010
Black shale and sand	1,023
Black shale and sand	1,031
Black shale and sand	1,040
Black shale—in it three feet of brown sandstone	1,062
Black shale and sand	1,070
Shale, with streaks of oil	1,076
Shale	1,082
Black shale and sand	1,096
Shale and more oil	1,102
Chocolate-colored sand	1,110
Stray chocolate sand (no oil)	1,150
Black shale	1,165
Black shale	1,178
Black shale	1,200
	1,400

BITUMEN.

Bitumen and bituminous rock have been found in large quantities on the land of J. Sargent, near Sargent Station, six miles south of Gilroy, which were described at length in the seventh annual report. Bitumen has since been used in Gilroy for the manufacture of illuminating gas, and some has been shipped to San Francisco for paving work.

Mr. E. A. Holloway, the manager of the Gilroy Gas Works, states that he has used bitumen with good success for the manufacture of illuminating gas at his works. He used ordinary gas retorts, but found the gas required a different process of purification than the product from coal. He is about to patent a suitable process and to put in retorts and apparatus of his own design, and at an early date he expects to light the town of Gilroy from this source. He states that one pound of this bitumen yielded sixteen cubic feet of gas, which was four times the amount obtainable from the coal he had been using.

GOLD AND SILVER.

Prospects of gold and silver have been discovered in the creeks of the Mount Hamilton group, and Santa Cruz Mountains. Gold was discovered in the bed of the San Francisquito Creek, near Mayfield, eighteen years ago, and a placer camp was started, but was soon abandoned. Gold was also panned out in the pioneer days in Coyote Creek, within the present limits of the City of San José, but in trifling quantities. Specimens of silver-bearing quartz, purporting to have been discovered in the vicinity of Mount Hamilton, have also been brought into San José. Mr. Hahn, who lives in Alameda Township, states that he discovered a quartz ledge in the Coast Range, that the ledge runs northeast by southwest, and that the croppings, which are three feet wide, assayed $4 in silver and 80 cents in gold per ton.

MANGANESE

Occurs in the Bergessa District at the mouth of Penetencia Creek.

COPPER.

On the Hahn ranch a claim was worked in 1864 and 1865.

CHROMITE.

On the Hahn Ranch is also an extensive deposit of chromite. It has been worked in several prospect holes and scattered openings that are distributed over some twenty acres. The principal opening is partially caved, but the body of chromite is said to be several feet wide at that point. It occurs in a bluish decomposed serpentine that becomes gray upon exposure. Between one hundred and two hundred tons have been shipped. It can be delivered on board the cars at Guadalupe Narrow Gauge Railroad for $8 per ton, and yield a fair margin of profit.

MINERAL SPRINGS.

There are many mineral springs in Santa Clara County, several of which are popular places of resort.

At Alum Rock

There are nine different springs, the waters of which being hot and cold, vary in character of the elements they hold in solution. These are situated on the city reservation, seven miles east of San José.

Congress Springs

Are in the Santa Cruz Range, three miles above Saratoga, and about twenty miles from San José.

Azule Seltzer Springs

Are three miles north of Congress Springs, and thirteen miles from San José.

Vichy Spring,

An analysis of the water of which was given in the sixth annual report, is on the south bank of the creek at the Hacienda, at New Almaden. It

was at one time a flowing mineral spring, its waters being highly impregnated with carbonic acid gas. It is now boarded up, and the manager at New Almaden works states that it has ceased to flow, and that the little water it contains is no longer permeated with gas. He suggests that the deep workings of the New Almaden Mine are the cause of the change in the character of the waters of the spring and of its partial extinction.

Gilroy Hot Springs

Are twelve miles east of Gilroy. The temperature of these waters varies from 109 to 115 degrees.

Blodgett Springs

Are about eight miles from Gilroy.

Madrone Soda Springs

Are twelve miles east of Madrone.

SANTA CRUZ COUNTY.

This, like so many other California counties, derives its name from an old Spanish mission. The term Santa Cruz, translated into English, signifies "The Holy Cross." This county is bounded on the north by San Mateo, on the northeast and east by Santa Clara, on the south by the County and Bay of Monterey, and on the southwest and west by the Bay of Monterey and the Pacific Ocean.

The Santa Cruz Mountains, a section of the Coast Range, strikes southeast along the entire northeastern border of the county. The summit of these mountains is the dividing line between this and Santa Clara County. Lying between these mountains and the sea is a lower ridge of the Coast Range, its trend corresponding to that of the seacoast. More than three fourths of this county consists of hills and mountains, all of which are well timbered with pine, oak, and redwood. Large quantities of lumber are manufactured from the pine and redwood, most of which finds a market in San Francisco and San José, being shipped thither either by rail or from the several small coves and harbors along the coast. The Santa Cruz Mountains are well watered and many streams flow through the cañons. Many of these run directly west into the ocean, while a large number unite to form the Lorenzo River, which courses south through the middle of the county and empties into Monterey Bay. Nearly the whole of this county is covered with a deep, rich soil, and its valleys are remarkable for their fertility.

MINERAL RESOURCES.

The metals and minerals as yet discovered in the county are gold, silver, coal, bituminous rock, quicksilver, and lime, together with sufficient building stone for local purposes. Of these, gold and silver, petroleum, in the form of bituminous rock, lime, and building stones are all that can be counted as known sources of actual mineral wealth.

GOLD AND SILVER.

Placer mining is carried on along various creeks in this county when water is abundant, and generally yield fair wages to those engaged in it.

The sluice and rocker have been familiar sights both on Wardell Creek and at Gold Gulch, near Felton, and on Major Creek, on the ranch of J. L. Thurber. At the latter place three men within thirteen days took out thirteen ounces of gold with sluices and plain riffles, no quicksilver being used. The gold was coarse and rough, some pieces being attached to rose-colored crystalline quartz. The largest pieces ranged in value from 25 cents to $10, the majority being the size of a grain of wheat; there was no fine gold. The gold was worth about $18 per ounce. Parties have mined on the creek for four or five years, and it is stated that over $28,000 worth of gold has been shipped through Wells, Fargo & Company at Santa Cruz. In early days a bowlder, the size of which was estimated at some sixteen cubic feet, was discovered in Gold Gulch, near Felton, which, when milled, yielded some $33,000. A small mill was erected on the spot, but, although a tunnel one thousand two hundred feet long was run into the hill in hope of striking the ledge from which the bowlder came, nothing remunerative was developed. Various attempts have been made to discover the source of the placer gold, but heretofore prospecting has met with but little success in the county, the great obstacle being the depth of soil covering the rock formation, and the dense growth it maintains, both of which prove a hinderance to the prospector and geological observer; yet some few ledges have been unearthed.

The only instance of gold-bearing quartz veins that have come under the notice of the Bureau in Santa Cruz County this year was on the ranch of F. B. Stribling, three and a half miles north of Santa Cruz, on the road to Ben Lomond. There, careful prospecting on the part of Mr. Stribling discovered several veins of gold-bearing quartz; upon these quite a little work has been done, and the ore has been milled to a profit. All of these veins occur upon the west side of a ravine upon the ranch, within a few hundred yards of one another. The largest veins have been traced for some distance upon the lands of other parties. The upper workings on this property consist of a tunnel run on the course of the vein for a distance of fifty feet, and a winze of five feet in depth. The vein is composed of quartzose rock mixed with clay, averaging about twenty inches in thickness, having a strike of northwest and southeast and dipping to the east of north at an angle of about 65 degrees; this is the general direction of the country rock in the vicinity. At the end of the tunnel the vein becomes more clayey, and a horse of iron-stained rock has been encountered. At no point is this working more than fifty feet below the surface of the ground. From this tunnel thirty-three and a half tons of ore have been milled, which yielded $710. The lower works are about three hundred yards further down the creek, where a tunnel one hundred and sixty-five feet long has been run upon the vein, which varies from six inches to three and a half feet in width. This vein is composed of quartz and clayey matter, showing sulphurets, and assaying from $6 to $10 per ton, and is accompanied by a "gouge" on one side or the other of light-colored clayey matter.

The vein runs northwest by southeast and is nearly perpendicular. This vein was first prospected by a shaft sunk in the level ground to the west of the ravine, but the working is now caved and abandoned, Mr. Stribling's object being to strike the vein by means of a tunnel at a lower elevation. About seventy feet below the upper working, a small vein about one foot wide crops out, running west of north by east of south, and dipping west of south at an angle of about 70 degrees. Belonging to the property is a mill run by steam power, each stamp dropping four inches and having a crushing power of one ton in twenty-four hours, through a No. 11 slot screen. Most of the gold is caught by the quicksilver in the battery. Of

the thirty-three and a half tons referred to an accurate record was kept. The assay returns on the bullion obtained were as follows:

Bullion Assay.

Before melting	58.75 ounces.
After melting	57.26 ounces.
Gold, 586 fineness; value	$693 20
Silver, 402 fineness; value	17 60
Total value	$710 80

Prospecting has also been carried on in Gold Gulch by Messrs. Bently and McLellan, who have run a tunnel into the hill in a southerly direction for a distance of over two hundred feet, in the hopes of striking a "blind lead," which might prove to be the ledge from which gold in the gulch below was derived.

These workings are in an unaltered sedimentary formation, but granitic rocks crop out above them a few hundred yards away. This tunnel for the first one hundred feet penetrated a gray sand, which passed into a stratum of calcareous rock containing fossil shells and underlaid with sand. At a distance of one hundred and ninety feet, strata of clay and shell marl, followed by quicksand, were passed through. This quicksand gave great trouble, and it was only by driving lagging ahead of the working that it was eventually overcome. At a distance of two hundred and ten feet a stratum of dark-colored and apparently carbonaceous matter was encountered, overlaid by an iron-stained sandy rock. These strata taken together were about sixteen inches in thickness. The formation at the end of the tunnel dips to the east of south at an angle of about 25 degrees. Work is also being commenced to prospect a ledge of auriferous rock near the summit of Ben Lomond.

AURIFEROUS SANDS.

Auriferous black sand is worked in the San Andres Hills, half a mile from the San Andres Station, on the northern division of the Southern Pacific Railroad, by the San Andres Black Sand Mining Company. This deposit was discovered several years ago upon the land of Peter Leonard, and the above mentioned company was organized by San Francisco parties in 1886 to work the deposit. These sands are the remains of an old sea beach, now forming dunes and hills of friable sand rock and beds of sand. It is one of the latter deposits in which these black sands, carrying the gold, occur. The auriferous strata vary from two to seven feet in thickness, sometimes being interstratified with sand of a lighter color. They are said to assay from $2 to $50 per ton, of which about 90 per cent can be saved by the present process. Associated with the gold is a small percentage of platinum and iridium. Beneath the auriferous black sand is a stratum of light-colored barren siliceous sand, and above it is an argillaceous sand rock.

These deposits are from thirty to sixty feet below the surface of the ground, and dip with a slight inclination towards the southeast. They extend five or six miles in length, following the coast line at a distance of three quarters of a mile inland, and are from one hundred and fifty to three hundred feet in width. These sands also contain pebbles of quartzose rock, but no fossils have been observed. The workings of this company consist of a three hundred-foot tunnel, which at present is only partly timbered. The sand is first dumped on an inclined drier, heated by a petroleum furnace; from the drier it gravitates into a hopper, and is

conveyed by an Archimedean screw into a revolving cylinder, holding longitudinally bars of inch iron, which crush the lumps until they pass through a twenty-four-mesh screen with which the cylinder is covered. The screenings then fall into a wide-mouthed hopper, with an inclined bottom, which causes them to pass into a third hopper, whence they are elevated by buckets on an endless belt to an oven, which has an inclined floor, and there heated by the waste heat from the petroleum furnace. From the furnace the material gravitates into tubes, which are set in an iron cylinder, also heated by the furnace below. The bottom of this cylinder has a tubule, which conveys the sand into another cylinder, which is "bridled" across the top of a pot of molten lead, and extends downwards to within twelve inches of the bottom of the pot. This cylinder contains a revolving screw, which forces the sand to the bottom of the lead. Attached to the screw are stirrers, which stir the sand as it rises in the lead. This screw is driven by sprocket wheels, which also move a scraper that revolves on a level with the top of the pot, and discharge the tailings through an outlet. The lead bullion is drawn off through a tap hole at the bottom of the pot. From the outlet at the top of the lead pot, the tailings enter a cylinder fourteen feet in length, in which there is a screw which conveys the sand to a revolving cylindrical sixty-mesh screen. This screen sifts the tailings into a car, which conveys them to the dump. An experimental run of four days was made with this plant, but owing to the imperfections in the casting of the lead pot, work had to be suspended until a new one could be procured. The proprietors of these works state that work will be resumed by the end of October. They also say that experimental workings of this process made in San Francisco proved that 90 per cent of the gold could be saved. The capacity of the present works is said to be one hundred tons in twenty-four hours.

Upon the present seabeach for a distance of about ten miles along the Bay of Monterey, extending east from Soquel Point to Pajaro and Embarcadero, black sand has been washed at intervals for fifteen years during the winter months. It is said that the washers have averaged from $2 to $3 per day, per man, the sand containing at times as much as $2 50 per ton in gold. These sands are shifted and washed by the winter's storms, which sometimes so cover the black sands with a barren gray sand as to render their workings unprofitable during the entire season. It is said that the bedrock beneath the black sands is a sandstone, upon which the black sands concentrate. The gold is mostly in small particles, and is about 889½ fine. The sand also contains a small percentage of platinum. These deposits have been mostly worked with China pumps, toms, and blankets, although a variety of apparatus has been constructed for that purpose. Mr. J. Arano, of Aptos, who has been periodically connected with this business for some fourteen years, has shipped $6,000 worth of gold within that time. The washers have been principally white men. Gold washing has also been carried on at Wardell's Beach, almost on the line between San Mateo and Santa Cruz Counties.

COAL.

There has been much prospecting for coal about fifteen miles north of Watsonville, in the Santa Cruz Range. Several small veins have been discovered. Small quantities of coal have been mined on the Corralitos Creek, and croppings have been found on the Valencia Creek, also in the neighborhood of Felton.

PETROLEUM.

The bituminous rock deposits which have been described in the report of 1887 are still yielding large quantities of paving material. Messrs. Williamson & Garrett, of Santa Cruz, have leased the bituminous rock deposits on the Pio Ranch, and in six months' time have shipped about a thousand tons of the material. Their principal shipments have been to San José, and the price obtained has been $5 per ton, delivered at Santa Cruz.

A quarry of bituminous rock is also being opened on the ranch of A. S. Silvey, between Santa Cruz and Williams Landing. No shipments have as yet been made.

Shipments of bituminous rock, for the year ending August, 1888: Santa Cruz Bituminous Rock Company, 8,799,830 pounds; Pacific Paving Company, 5,564,195 pounds; Williams & Garrett (approximate), 2,000,000 pounds; total, 16,364,025 pounds.

OIL

Has been discovered at several places, and borings have been made at Major Creek and in Green Valley; at the latter place the boring is said to be over five hundred feet deep. Oil was struck at both places, but not in sufficient quantities to warrant a further prosecution of the enterprise.

CINNABAR.

This ore has been found in small quantities in the Loma Prieta Range, near the headwaters of the Soquel Creek; also upon Ben Lomond.

LIME.

The lime kilns of Davis & Cowell are situated a few miles northwest of Santa Cruz; the lower kiln being two and one half miles distant from the town, and the upper about four miles. At both places old fashioned pot kilns are used. These kilns are built of masonry and arranged in sets of three each, so that three can be burning while three are being emptied and refilled. The lower kilns produce from one thousand six hundred to one thousand seven hundred barrels of lime per week, and the upper from one thousand two hundred to one thousand three hundred. It requires from four and one half to five days' time to burn a kiln with dry wood; the fuel used is pine and redwood.

The Lime Kilns of Holmes & Co.

There are two sets of kilns belonging to this firm, in the neighborhood of Felton. The upper kilns are about one mile from the town, and several hundred feet above it. There are eight kilns at the upper works, varying in capacity as follows:

Number of Kilns.	Capacity in Barrels.	Cords of Wood Used.	Days to Burn with Good Wood.	Firemen to Shift.
3	1,500	120	4	2
2	830	60	4	2
3	400	30 to 55	4	1

Redwood and pine are both used as fuel and considered equally good. The lime produced fills about four fifths of the space occupied by the limestone before burning. For all the Santa Cruz kilns the barrels are made on the premises. The limestone quarry is a few hundred feet above the upper kilns, which are supplied by trucks, run by a gravity pulley. The limestone is a fine crystalline variety, usually pure and white, but sometimes of a bluish cast; it occurs in granitic rock. About twenty men are employed in this quârry.

The lower kilns are six in number; they are sixteen feet high, their interior diameter at the top being ten feet, and the exterior fourteen feet, and have a capacity of four hundred barrels each. They are the pot kilns, but of a somewhat new design. Up to the height of eight feet the basement, built of solid masonry, is surrounded by a casing of double boiler plate, which is strengthened on the inside with eighteen inches of stonework and a lining of firebrick set edgewise. There are two firedoors at the base of the kiln, by which the draught can be regulated during the process of firing. The doors are considered a great improvement on the old open fireplace, since they not only prevent loss of heat, but also create a better draught, thereby occasioning a more complete combustion of the fuel. One of these kilns takes four to five days to burn a charge, according to the wood, and consumes about thirty-five cords, requiring one man to fire. One of these kilns can be filled by two men in two and one half days.

The I. X. L. Lime Company.

The works of this company are situated about one and a half miles from Felton. They consist of three kilns of the same pattern as the upper kilns of the Holmes Company. The limestone is a similar fine, crystalline variety, and the quarry presents an unbroken face of over one hundred feet. The production here is about fifty thousand barrels annually.

BUILDING STONE.

The rock principally used for building purposes in this county, especially at Santa Cruz, is a crystalline limestone, which occurs abundantly, and affords an excellent building material, although marble workers state that it is too seamy for the finer class of work. A variety of granitic rock has also been employed to a limited extent, and attempts are now being made to open a quarry of it in the neighborhood of Santa Cruz. This rock has been used in building the jail and Court House of Santa Cruz, and apparently is of an enduring character.

GRANITE QUARRY.

This quarry is about one mile from Santa Cruz on the old San José road, and some of the rock appears to be good building material. In a great deal of it, however, the lack of homogeneity peculiar to the granitic rocks of the Coast Range is remarked.

MINERAL SPRINGS.

There are several mineral springs in the county, but are only locally known. On the ranch of B. C. Nichols there is a spring whose waters issue from a decomposed shale rock. Mr. M. F. Baumgarten, who made an analysis of these waters, reports:

	Grains to the Gallon.
Silica	6.41024
Sodium chloride	.10635
Sodium sulphate	12.08658
Ferric sulphate	10.91725
Calcium sulphate	49.34175
Magnesium sulphate	105.09475
Total	183.95692

(Calculated for the gallon of 231 cubic inches.)

SACRAMENTO COUNTY.

This county is named after the Sacramento River, which, flowing along its western border, separates it from Solano and Yolo Counties.

Sacramento is a Spanish word, the orthograpy of which differs so little from the English that to one conversant with the latter the meaning of the word is obvious. It would have been a graceful compliment to General Sutter had the name New Helvetia, given to the town laid out by him on the site occupied by the present City of Sacramento, been conferred on the latter as well as on the county itself. Helvetia was the ancient as it is now the classic name of Switzerland, Sutter's native country, and, having himself thus honored it, we might well have retained somewhere in our geographical vocabulary a name so preferred by the old pioneer.

Sacramento County is bounded by Sutter and Placer on the north, El Dorado and Amador on the east, San Joaquin on the south, and by Solano and Yolo Counties on the west.

The surface of this county is generally level, a section along the eastern side rising into low hills and rolling prairies. Along the east side of the Sacramento River extends a belt of tule land, which, towards the southern boundary of the county, expands to a width of fifteen miles. Scattered sparsely over the country is a growth of oaks—the trees on the low hills small and scrubby, on the plains mostly of large size. Sycamore and cottonwood are found along the rivers and watercourses, there being no timber suitable for making lumber. Across the county in a southwesterly course flow the American River in the center and the Cosumnes River towards its southern border. Dry Creek, running parallel with the Cosumnes, separates this county from San Joaquin County.

MINES AND MINERALS.

In the early days of mining a great deal of gold dust was taken from the placers in this county, Mormon Island, Michigan Bar, and several other localities having afforded good diggings of this kind. In the low hills on the east a considerable extent of shallow placers have also been worked, some of these until quite recently.

The most of the gold now produced in Sacramento is taken out in the vicinity of Folsom, chiefly along Alder Gulch, by the Portuguese and Chinamen. The deep deposits here are worked by shafts and drifting, the shallow by hand sluicing in the dry season and ground sluicing in the wet, when there is free water. There are gold-bearing quartz veins in the east-lying hills, but they are mostly small, and have been but little worked. In these hills occurs a belt of serpentine containing chromic iron in small bunches and pockets.

GRANITE.

In the neighborhood of Folsom occurs an extensive bed of excellent granite, which for many years has been largely worked.

At the quarry of David Blower, two miles east of Folsom, opened ten years ago, there is exposed a thirty-foot face, twenty feet above and ten below the surface. About fifteen tons of roughly dressed stone are shipped from this quarry weekly, the most of it being used for cemetery work and street curbs. Thirteen men are employed here at wages ranging from $2 50 to $4 per day.

In the quarry on the State Prison grounds at Folsom, a large force of convicts are employed getting out stone for the dam being built by the State, on the American River.

Most of the cobblestones used for paving the streets of San Francisco were taken from the banks of the American River, in the vicinity of Folsom.

CLAY.

At Michigan Bar, on the Cosumnes River, occurs an extensive bed of potter's clay. Being a good article, and easily obtained, large quantities of this clay are taken out and shipped to the potteries at Sacramento, San Francisco, and elsewhere in the State. Great quantities of bricks are made from the more common clays found abundantly in this county.

SAN JOAQUIN COUNTY.

This county takes its name from the river San Joaquin (Spanish, Joachim) flowing through its western part. It has for boundaries Sacramento County on the northwest and north, Amador and Calaveras on the northeast, Stanislaus on the south, and Alameda and Contra Costa Counties on the west.

The surface of this county is nearly a dead level throughout, the greatest altitude within its limits not exceeding three or four hundred feet. Half of its area, including a vast expanse of tule land along the San Joaquin River, does not rise to a greater elevation than eighty or ninety feet above sea level, much of this tule land being overflowed at high tide. This county is watered by the San Joaquin River flowing north through its entire length, the Calaveras traversing it centrally in a westerly direction, and by the Mokelumne River running across its northeastern part, the Stanislaus River separating this from Stanislaus County. The indigenous timber growth is limited to a few oaks scattered over the central portion of the county, there being no trees native to the soil fit for making lumber. Arboriculture is, however, being practiced here to an extent that promises to furnish in the course of a few years wood enough for fuel at least. Seventy-five per cent of the land in this county is capable of producing good crops of the cereals in seasons favorable as regards rainfall. In dry years the crops in many parts, more especially throughout the region west of the San Joaquin River, are apt to suffer from drought. To supply water for irrigation where needed, many large ditches have within the past few years been built here, with others in course of construction or projected. The principal towns in this county are Stockton, the county seat, with sixteen thousand inhabitants, Lodi, Woodbridge, and Lockeford, the three last mentioned being each the center of a prosperous agricultural district.

MINES AND MINERALS.

The placer diggings found on a few river bars and along some of the shallow gulches in the eastern part of San Joaquin having been worked out long ago, there has been left to this county neither gold mines nor, so far as known, other metalliferous deposits of value. Building stones, however, of good quality, and clay, suitable for making brick, are plentiful here, and natural gas has quite recently been obtained in the vicinity of Stockton in such quantities and under such conditions as warrant the belief that a more abundant and perhaps permanent supply will be obtained by deeper borings.

San Joaquin County, lying as it does between the Mount Diablo section of the Coast Range upon the west and the foothills of the Sierras upon the east, is naturally an agricultural county, and were it not for the gas wells which have been developed within its borders during the last few years, one would be apt to overlook the fact of the dependence of the vegetable upon the mineral world, and consider San Joaquin County as having very little to do with mineralogy. The mineral of chief importance in San Joaquin County is water, and perhaps it will be well to preface the county's mineral resources by a few words on that important constituent of natural economics. In the opinion of Mr. Jerome Haas, the veteran well borer of the San Joaquin, artesian water can be struck throughout the greater part of San Joaquin County at a depth of about one thousand feet; in fact, it usually rises to the surface from any boring seven hundred feet in depth. Ordinary wells need not be deeper than eighty to one hundred and twenty feet, to obtain good water. This surface water is always hard. Beyond a depth of about one thousand three hundred feet the water is usually brackish, and unfit for domestic use. Mr. Haas says that an artesian well, carrying an eight-inch pipe, one thousand feet in depth, can be bored in most parts of San Joaquin County for about $1,800. The deepest borings in San Joaquin County, of which any accurate records are available, have failed to discover any rocky strata, unless the green sandstone mentioned in the boring of the Stockton Court House artesian well be regarded as such; it was probably a stratum of compact sand and clay that could hardly be regarded as a rock.

The drill below a depth of two hundred and fifty feet discloses nothing but alternate layers of variously colored sand and indurated clay. From the uniformity of depth at which the various flows of water are found, and observations on the relative occurrence of various strata of clays and sand, that Mr. Haas has encountered in well boring in San Joaquin County, he believes there has been but little disturbance of strata beneath a depth of two hundred and fifty feet. As general stratagraphical features, he has observed that the further to the east in the valley the wells have been, the lower and more stony the soil has become; while further to the west it has been finer in character. That as a rule the deeper the boring the thicker are the beds of clay, and that the yellow clay is very seldom found after striking the blue. Mr. Haas considers that the best and most authentic account of the stratagraphical formation on which the town of Stockton stands, is the record of the strata penetrated while boring the artesian well in the Stockton Court House square, in 1858. He also says, that in the main it corresponds with the formation he has encountered while boring wells in other parts of the county. Samples of the various strata were formerly preserved in the old Agricultural Hall. This building was unfortunately damaged by fire, and the samples were burned, together with the original records. Happily a copy of the latter had been made by Major

Orr, who was the proprietor and editor of the "Stockton Independent," and published in his paper. It is worth preserving as the only authentic record extant of the stratagraphical formation underlying the town of Stockton, and probably the greater part of San Joaquin County. The water from this well issues at a temperature of 77 degrees Fahrenheit, and was long used for the city supply.

STRATA MET WITH IN BORING ARTESIAN WELL AT STOCKTON, IN 1858. TAKEN FROM THE "INDEPENDENT."

Character of Strata Passed Through.	Thickness of Strata—Feet.
Black loam	6
Red clay and sand	6
Dark red clay and sand	18
Blue clay, mica, and sand	10
Blue clay, hard, highly stratified	4
Blue clay, mica, and sand	3
Blue clay, hard, highly stratified	4
Green sandstone and clay, very hard	29
Blue clay, sand, and gravel, slightly impregnated with gold	2
Blue clay, sand, and gravel	18
Green sandstone, clay, and mica, hard	15
Fine gravel	5
Gray quicksand	15
Blue clay	8
Gray sand and clay	27
Dark blue clay and sand	33
Coarse gravel and pebble stones	57
Blue clay	7
Gray sand	12
Blue clay and sand conglomerate	12
Light gray sand	3
Blue clay	6
Light sand	9
Blue clay	1
Fine gray sand	12
Dark clay	2
Fine gray sand	7
Clay and sand	10
Coarse gray sand	7
Light clay	19
Coarse sand	14
At 340 feet in this sand a redwood stump was found and a stream of water ascended to within 3 feet of the surface.	
Light clay	8
Fine gray sand	1½
Light clay	20½
Coarse gray sand	20
Clay, very hard	4
Gray sand and clay	5
Clay	20
Coarse gray sand	3
Light clay	15
Fine, gray sand	4
Light clay and sand	1
Coarse gray sand and clay	1
Light blue clay	11
Gray sand and clay	7
Light blue clay	15
Fine gravel	1
Light blue clay and gravel	13
Fine gravel	25
Clay and sand	2
Sand and clay	5
Coarse gray sand	6
Fine blue clay	8
Fine gray sand	42
At a depth of five hundred and sixty feet in this stratum of sand obtained a stream of water rising five feet above the surface.	

Character of Strata Passed Through.	Thickness of Strata—Feet.
Gray sand and clay	15
Light clay and sand	6
Fine gray sand	24
Clay and sand	3
Fine sand	9
Fine gravel	3
Fine gray sand	5
Coarse sand	2
Gray sand and clay	8
Clay and sand	5
Clay	5
Coarse gray sand	2
Fine light blue clay	4
Hard chocolate-colored clay	2
Blue clay	2
Fine gray sand	30
Clay and sand	8
Gray sand	4
Light clay	10
Coarse sand	6
Blue clay	4
Dark clay, very hard	2
Gray sand	4
Blue clay	14
Light drab clay	3
Very fine gray sand	24
Light drab clay	1
Light gray sand, very fine	27
Dark gray sand	18
Light blue clay, very hard	22
Light clay	11
Dark chocolate clay, very hard	10
Light clay, very hard	15
Fine gray sand (good stream of water)	2
Clay and sand	11
A large stream of water was obtained in this stratum, rising seven feet above the surface.	
Fine sand and gravel	10
Blue clay	20
Sand and gravel	6
Blue clay	27
Clay, gravel, and mica	14
In sand	2
Total depth of well	1,002

INFLAMMABLE GAS.

The inflammable gas of San Joaquin County, which has been described at length in the report of the State Mining Bureau for last year, is now being turned to practical use. At the Crown Mills, of which Mr. J. M. Welch is manager and part owner, as already reported, there is a gas well one thousand three hundred and thirty feet deep, which yields fifteen thousand cubic feet of gas in twenty-four hours. It is now used for heating the boilers of the mill, being burned in the same furnace together with a small quantity of coal. Pipes, connected with the gas receiver, lead directly into the bottom of the furnace, and a great saving of fuel is effected thereby. Mr. Welch made several experiments upon the gas as an illuminator, with a view to lighting the mill with it. He also tried passing the gas through coal oil, and also gasoline, burning the product with an ordinary gas burner. He found that the plain natural gas burned with the Lungren burner was preferable. When this burner was used, each lamp was found to be equivalent to about two and a half ordinary gas jets. As soon as a sufficient number of Lungren lamps arrive from the East, the

natural gas will be used entirely as an illuminator in the Crown Mills. It will take about forty lamps to light the mill, and will effect a saving of about $140 per month.

The Old California Well Company was reincorporated in April last, under the name of the Stockton Natural Gas Company. Their well, which is situated on the southwest edge of the city, is over two thousand feet deep, and yields seventy thousand to eighty thousand cubic feet of gas in twenty-four hours. They propose to lay pipes and run it into the city for lighting and heating purposes. The gas, as it issues from the well, burns with a luminous flame, producing a slightly empyreumatic odor, due, no doubt, to imperfect combustion, as no smell is perceptible when the gas is burned with the Lungren burner. The following is an analysis of the gas, made for Mr. Haas, who bored the well, and is a Director of the Stockton Natural Gas Company:

ANALYSIS OF INFLAMMABLE GAS FROM THE WELL OF THE STOCKTON NATURAL GAS COMPANY.

Marsh gas, CH_4	83.00
Hydrogen, H	.03
Oxygen, O	.06
Carbonic dioxide, CO_2	.05
Carbonic Oxide, CO	Trace.
Total	83.17

The artesian wells bored during the past year are as follows: Artesian well four miles east of Stockton, on Bishop ranch, one thousand one hundred and eighty feet deep, no gas, good water; artesian well at paper mills, Stockton, one thousand two hundred and twenty-five feet, yields good flow of water, and probably as much gas as at the Crown Mills; no use is made of the gas at present. The old Standard well on the old Camp road is now owned by the Standard Gaslight and Fuel Company. They have commenced boring a second well one thousand three hundred and seventy-five feet southwest from the old one. Operations upon it are suspended for the present, but it is their intention to resume work at an early date.

BRICK CLAY.

The neighborhood of Stockton is well supplied with brick clay. The manufacture of bricks is carried on by the San Joaquin Improvement Company, J. C. Smith, and Saul Confer. The yards of the San Joaquin Improvement Company are upon the west bank of the San Joaquin River. The clay used is about forty feet in depth. The following analysis of clay from the brickyards of the San Joaquin Improvement Company has been urnished by the company:

Insoluble matter	73.810
Soluble silica	9.547
Potassa	.292
Soda	.245
Lime	.844
Magnesia	1.176
Manganese oxide	.044
Ferric oxide	5.386
Alumina	5.184
Phosphoric acid	.312
Sulphuric acid	.061
Carbonic acid	Trace.
Water and organic matter	3.202
Total	100.163

MINOR ITEMS.

A deposit of manganese has been opened in Tulare Township, about twelve miles southeast from Tracy, and gold washing has been carried on to a limited extent by Chinamen upon the Mokelumne River, in the northeast corner of the county.

Street gravel, which was formerly brought to Stockton from Milton, in Calaveras County, is now obtained in large quantities at Nightingale, about two miles southeast from the city limits.

Good foundry or molding sand is found within three miles of Stockton, and used in the Globe Iron Works of that city.

SHASTA COUNTY.

This county derives its name from Mount Shasta, which, when the county was created, stood within its limits. When, in 1852, Siskiyou County came to be organized, it was made to take in that portion of Shasta which contained this imperial mountain, thereby depriving the name originally given to this county of its significance and fitness. Shasta, despite such curtailment of its original proportions, remains a very large county, its area comprising three thousand seven hundred and sixty-five square miles—two million four hundred and ten thousand acres of land. As at present organized, this county is bounded on the north by Siskiyou, on the east by Lassen, on the south by Plumas and Tehama, and on the west by Trinity County.

The whole of this county is more or less mountainous, the Sierra Nevada striking across its eastern and a branch of the Coast Range striking its western border, the crest of the latter forming the boundary line between this and Trinity County. Aside from these more prominent ranges the face of the country here is diversified by many short straggling chains of mountains and irregular masses of hills. Standing in the Sierra Nevada within the limits of this county are several high peaks. The principal of these, Lassen, has four distinct summits, the highest reaching an altitude of ten thousand five hundred and seventy-seven feet above the level of the sea. These summits are the fragments of what was once a great crater rim, formed when this was an active volcano.

Shasta is well watered by the Sacramento River flowing south across it, and by the numerous tributaries of that stream, of which the McCloud River and Pitt River, coming in from the northeast, are the largest. Shasta abounds with mineral springs, many of them thermals, some of which boil fiercely with a loud noise.

The western part of the county and also the greater portion of the Sierra Nevada lying to the east are covered with forests of pine, spruce, and fir. The balance of the county is but poorly timbered, much of the northeastern part being nearly treeless. In the southern portion of Shasta there is found along the Sacramento River a considerable extent of good farming land, most of the land suitable for tillage elsewhere being confined to the creek bottoms and small mountain valleys.

Besides gold and silver Shasta contains the useful metals and minerals in great variety; her deposits of coal, iron, and copper, though not much developed, being no doubt valuable.

GOLD-BEARING QUARTZ MINES.

CALUMET MINE.

This property is situated in the Buckeye Mining District, six miles north of the town of Redding. Size of claim, three thousand four hundred and thirty-five feet by six hundred feet. The course of vein is northeast and southwest, with a dip to the southeast of 75 degrees; average width, four feet. The developments consist of eight hundred feet of tunnels and an incline shaft down one hundred and forty feet, giving a vertical depth of one hundred and thirty feet. Formation, slate and porphyry; hanging-wall being slate, foot-wall porphyry. Most of the underground work has been timbered; cost of timber $15 per thousand. For the introduction of water and convenience of transportation, eight miles of ditch, one mile of wagon road, and three miles of tramway have been built here, the latter being for the carriage of ore to works. The mill consists of twenty-four stamps, two Paul circular batteries, twelve stamps in each, four Paul blanket concentrators, and two arrastras to each battery. The batteries are six feet in diameter, outside circle is vertical, inside inclined; the plates are six inches wide circling the battery. Method of treating sulphurets is by desulphurizing, repulverizing, and amalgamation. The ore carries 2 per cent of sulphurets, containing iron, galena, and copper, valued at $150 per ton; stated cost of treating, $2 50. All the machinery is driven by a six-foot Knight water wheel.

Altitude	750 feet.
Length of ore shoot	3,435 feet.
Vertical depth reached in mine	130 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	100 pounds monthly.
Cost of mining	60 cents per ton.
Cost of tunnel	$2 50 per foot.
Cost of shaft	$7 per foot.
Number of feet timbered	200
Kind of timber	Pine.
Cost of timber	$15 per thousand feet.
Length of road built	1 mile.
Length of ditch built	8 miles.
Cost of transport of ore	15 cents per ton.
Character of ore	Quartz with iron and lead sulphurets.
Character of works	24-stamp circular battery.
Number of stamps	24
Weight of stamps	600 pounds each.
Drop of stamps	6 inches.
Drops	85 per minute.
Duty of stamp	1½ to 2 tons in twenty-four hours.
Kind of shoes and dies	Judson composition.
Size and character of screens	No. 8 wire.
Water used in battery	1¼ inches.
Dimensions of apron	6 inches, circling battery.
Kind of feeder	Challenge.
Kind of concentrators	Paul blanket.
Percentage of sulphurets	2
Stated cost of working sulphurets	$2 50 per ton.
Number of men in mill	5
Number of men in mine	15
Total number employed	20
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$1 50 per day.
Quantity of water used	100 inches.
Fall of water used for power	210 feet.

RILEY AND BLISS MINE,

Located January 15, 1885, is situated in the Backbone Mining District, nine miles northwest from the town of Copley. The claim is fifteen hundred by six hundred feet. The course of the vein is northeast and southwest, and dips to the north 85 degrees; average width of vein, ten feet. The mine is opened by means of tunnel and drifts. The tunnel is two hundred and thirty feet in length, and drifts to the amount of three hundred and forty-nine feet have been run. The vertical depth reached from surface is one hundred and fifty-five feet. The formation of both walls is porphyry. The length of the ore shoot has not yet been determined. Four hundred and seventy feet of the tunnel and drifts have been timbered. The cost of timber is about $20 per thousand. The company has built two thousand eight hundred feet of wagon road, for the transportation of ore to works. Cost of transportation is 40 cents per ton. The mine is equipped with a ten-stamp mill, run by water power. No concentrators are used. The supply of water consists of thirty-seven miner's inches, having a fall of one hundred and eighty feet.

Altitude	1,500 feet.
Length of ore shoot	Not determined.
Vertical depth reached in mine	155 feet.
Character of walls	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	250 pounds per month.
Cost of tunnel	$10 per foot.
Number of feet timbered	470
Kind of timber	Pine.
Cost of timber	$20 per thousand.
Length of road built	1 mile.
Cost of transportation of ore	40 cents per ton.
Character of works	10-stamp mill.
Number of stamps	10
Weight of stamps	850 pounds.
Drop of stamps	6 inches.
Drops	70 per minute.
Duty of stamp	1½ to 2 tons in twenty-four hours.
Kind of shoes and dies	Cast-iron.
Size and character of screens	Brass wire, No. 40.
Water used in battery	2 miner's inches.
Dimensions of apron	4½ by 4 feet.
Width of sluice	18 inches.
Length of sluice	14 feet.
Kind of feeder	Challenge.
Percentage of gold saved in battery	90
Percentage of gold saved on plates	10
Percentage of sulphurets	2
Number of men employed in mill	3
Number of men employed in mine	18
Total number employed	21
Average wages in mine	$2 per day, with board.
Average wages in mill	$2 50 per day, with board.
Average wages paid outside work	$1 50 per day, with board.
Quantity of water used in milling	37 inches.
Fall of water for power	180 feet.

AMERICA MINE

Is situated in French Gulch Mining District, two and one half miles northeast from the town of French Gulch. The property was located September 20, 1887. The course of vein is northeast and southwest; dip, 45 degrees to the north; average width is three feet; claim, one thousand five hundred feet by six hundred feet; length of ore shoot, about five hundred feet. Developments in the mine consist of an upper and a lower tunnel, the former thirty feet and the latter one hundred feet in length. Vertical depth

reached from surface two hundred feet. Hanging-wall, slate; foot-wall, porphyry. The surface ore here proves very rich, some $2,000 having been taken out with a hand mortar. The machinery consists of a water power five-stamp mill; no concentrators in use; ore transported to mill by means of a sled at a cost of $1 per ton. The owner proposes to enlarge his mill soon by adding five stamps.

Altitude	3,150 feet.
Length of ore shoot	500 feet.
Vertical depth reached in mine	200 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	60 pounds per month.
Cost of mining	$1 per ton.
Cost of tunnel	$4 per foot.
Kind of timber	Pine.
Cost of timber	$20 per thousand.
Length of road built	1 mile.
Cost of transport of ore	$1 per ton.
Character of ore	Quartz with sulphurets.
Character of works	5-stamp mill.
Number of stamps	5
Weight of stamp	750 pounds.
Drop of stamps	5½ inches.
Drops	85 per minute.
Duty of stamp	2 tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	No. 9, punched.
Water used in battery	1 inch.
Dimensions of apron	4 by 4 feet.
Width of sluice	3 feet.
Length of sluice	16 feet.
Kind of feeder	Self-made.
Percentage of gold saved in battery	90
Percentage of gold saved on plates	10
Cost of milling	70 cents per ton.
Number of men in mill	3
Number of men in mine	12
Total number employed	15
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$2 per day.
Quantity of water used in mill	20 inches.
Fall of water used for power	167 feet.

CENTRAL MINE.

This property is situated in the Old Digging Mining District, eight miles north of the town of Redding. The course of vein is north and south; dip, 60 degrees to the east; average width of vein, about six feet. The claim is one thousand five hundred feet by six hundred feet. The mine is worked through a tunnel two hundred feet in length. Five hundred feet of drifting has been done. Vertical depth from surface reached in tunnel, one hundred and seventy-five feet. This is a contact vein. Hanging-wall, granite; foot-wall, porphyry. The vein has been stoped nearly to the surface. The tunnel and drifts are timbered. Timber cost $30 per thousand. There are two Huntington mills on the property, and eight Frue vanners. The mills crush twenty-five tons of ore per day (of twenty-four hours). Of late the company has been sorting and shipping ore to the Selby Smelting Works.

Altitude	1,100 feet.
Length of ore shoot	500 feet.
Vertical depth reached in mine	175 feet.
Character of hanging-wall	Granite.

Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	150 pounds per month.
Cost of mining	$3 per ton.
Cost of tunnel	$6 per foot.
Number of feet timbered	700
Kind of timber	Pine.
Cost of timber	$30 per thousand.
Length of road built	One and one half miles.
Cost of transport of ore	50 cents per ton.
Character of works	2 Huntington mills.
Duty of mills	25 tons in twenty-four hours.
Size and character of screens	No. 6 slot.
Kind of concentrators	Frue.
Percentage of gold saved in mill	75
Percentage of gold saved on plates	25
Percentage of sulphurets	2
Value of sulphurets	$200 per ton.
Cost of working sulphurets	$15 per ton.
Percentage of value extracted from sulphurets	90
Number of men in mill	3
Number of men in mine	20
Total number employed	23
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$2 per day.
Wood used	2 cords per day.
Cost of wood	$2 50 per cord.

LOST CONFIDENCE MINE.

This property, better known as the Iron Mountain Mine, is situated in the Flat Creek Mining District, seven and one half miles north from the town of Shasta. The location was made April 8, 1880. The claim is one thousand five hundred feet by six hundred feet. Course of vein, northeast and southwest; dip, 45 degrees to the east; average width, one hundred and thirty feet. The ore shoot is continuous the entire length of the claim, and can be traced as far as the Windy Camp District, a distance of eight miles—the same character of ore showing in explorations made in the latter camp.

Developments on the mine consist of a tunnel two hundred feet in length, and one thousand feet of drifts. The vertical depth reached from surface is two hundred feet. The formation of both hanging and foot-wall is porphyry. The ore carries 25 per cent of sulphurets, valued at forty ounces in silver and $1 in gold per ton.

The method of working is amalgamation. The estimated cost of treating ore per ton is $17 when roasted, and $10 worked raw. Percentage of silver saved is 96 when roasted and 80 when raw. Only fifty feet of timbering has been done in the mine. The cost of timber is $20 per thousand. The company has built ten miles of wagon road. The ore is transported to the work, by means of a tramway, at a cost of 10 cents per ton. The method of treating ore is roasting and amalgamating. The mill is a frame structure, containing twenty stamps and sixteen combination pans.

Altitude	3,200 feet.
Length of ore shoot	1,500 feet.
Vertical depth reached in mine	200 feet.
Character of hanging-wall	Porphyry.
Character of foot-wall	Porphyry.
Kind of powder used	Hercules.
Quantity of powder used	160 pounds per month.
Cost of mining	25 cents per ton.
Cost of tunnel	$2 per foot.
Number of feet timbered	50
Kind of timber	Pine.
Cost of timber	$20 per thousand feet.

Length of road built	10 miles.
Cost of transport of ore	10 cents per ton.
Number of stamps	20
Weight of stamp	950 pounds.
Drop of stamps	7 inches.
Drops	90 per minute.
Duty of stamp	2 tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	No. 40, round-punched.
Kind of pans	Combination.
Number of pans	16
Percentage of sulphurets	25
Value of sulphurets	40 ounces silver and $1 gold per ton.
Cost per ton of working sulphurets	Raw, $10; Roasted, $17.
Kind of roasting furnace	Bruckner.
Number of roasting furnaces	1
Per cent of salt used in roasting	5
Wood consumed in roasting	½ cord per ton of ore.
Number of men in mill	10
Number of men in mine	20
Total number employed	30
Average wages in mine	$2 per day, with board.
Average wages in mill	$2 55 per day, with board.
Average wages paid outside work	$1 50 per day, with board.
Wood used	12 cords per day.
Cost of wood	$2 25 per cord.

CELESTINE MINE

Is situated in French Gulch Mining District, three miles northwest from the town of French Gulch; located April, 1887, and then known as the "Double Header."

The course of vein is northeast and southwest, dip 45 degrees to the east. Claim is one thousand five hundred feet by six hundred feet. Supposed length of ore shoot, five hundred feet. Development work consists of one thousand six hundred feet of tunnels. Vertical depth reached from surface, two hundred feet. The hanging-wall is slate; foot-wall, porphyry. Cost of mining per ton of ore, is $4, and $3 per foot in running tunnels. About one hundred feet of timbering has been done. Timber cost $20 per thousand. About one mile of wagon road has been built for ore transportation.

The ore contains 2 per cent of sulphurets; value per ton not stated; 95 per cent of value saved is in battery, and 5 per cent on plates. The improvements on the property consist of a five-stamp mill run by an overshot water wheel, using eighteen inches of water, having a thirty-four-foot fall.

Altitude	1,700 feet.
Length of ore shoot	500 feet.
Vertical depth reached in mine	200 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	100 pounds per month.
Cost of mining	$4 per ton.
Cost of tunnel	$3 per foot.
Number of feet timbered	100
Kind of timber	Fir.
Cost of timber	$20 per thousand.
Length of road built	1 mile.
Cost of transport of ore	25 cents per ton.
Character of works	5-stamp mill.
Number of stamps	5
Weight of stamp	850 pounds.
Drop of stamps	5½ inches.
Drops	85 per minute.
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	No. 40, slot.
Water used in battery	½ inch.
Dimensions of apron	4 feet by 4 feet.

Width of sluice	3 feet.
Length of sluice	6 feet.
Percentage of gold saved in battery	95
Percentage of gold saved on plates	5
Percentage of sulphurets	2
Value of sulphurets	Not stated.
Cost of milling	$1 50 per ton.
Number of men in mill	2
Number of men in mine	6
Total number employed	8
Average wages in mine	$3 per day.
Average wages in mill	$3 50 per day.
Average wages paid outside work	$2 50 per day.

MAMMOTH MINE.

This property is situated in the Buckeye Mining District, seven miles north of the town of Redding; located January, 1883. The course of vein is north and south; dip, 35 degrees to the east; average width about eight feet. The claim is one thousand five hundred feet by six hundred feet; ore shoot about one thousand feet in length. Developments on mine consist of two tunnels, No. 1 one hundred and twenty feet, and No. 2 two hundred feet in length. Vertical depth reached from surface, one hundred and fifty feet. Formation of both walls is porphyry. The cost of mining per ton of ore is $2. About three feet of tunnel are run per day, at a cost of $2 50 per foot, no timbers being used. The company has built three miles of wagon road. Improvements on the property consist only of miners' cabins. The ore is transported to railroad by means of wire tramway, at a cost of $1 per ton.

The owners are sorting and shipping ore to the Selby Smelting Works. They ship from two to three carloads per month, and state that it nets them $100 per ton. The greater portion of the ore is left on the dumps, not being of high enough grade to ship. The mine employs nine men—four in the mine and five are working on the outside. Average wages paid are $45 per month and board.

Altitude	1,100 feet.
Length of ore shoot	1,000 feet.
Vertical depth reached in mine	150 feet.
Character of hanging-wall	Porphyry.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	125 pounds per month.
Cost of mining	$2 per ton.
Cost of tunnel	$2 50 per foot.
Length of road built	3 miles.
Cost of transport of ore	$1 per ton.
Number of men in mine	9
Average wages in mine	$40 per month and board.

GLADSTONE MINE.

This property, consisting of the Gladstone, Helena, and Giant Mines, is situated in the French Gulch Mining District, four miles northeast from the town of French Gulch; located November 23, 1887.

The course of vein here is northeast and southwest; dip, 45 degrees to the northwest. Each claim is fifteen hundred feet in length and six hundred feet in width; hanging-wall slate, and foot-wall porphyry. Developments consist of tunnel two hundred feet in length and drift run west sixty-five feet. Vertical depth reached from surface is one hundred and thirty feet. The ore shoot is about five hundred feet long. Most of the development work done is on the Gladstone. In running the tunnel and

crosscutting the vein, three distinct ledges were encountered: No. 1, vein averaging two and one half feet; No. 2, five feet, and No. 3, four feet. The vein holds out the entire length of drift—one thousand feet. Southwest a tunnel thirty-five feet in length was run on the Helena Mine, showing three feet of ore. The Giant Mine has a tunnel seventy feet in length, all in ore; the vein here is about four feet wide. There is sufficient water belonging to the property to furnish power to run a twenty-stamp mill six months in the year.

Altitude	3,000 feet.
Length of ore shoot	500 feet.
Vertical depth reached from surface	130 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	50 pounds per month.
Cost of mining	$4 per ton.
Cost of tunnel	$3 per foot.
Number of feet timbered	80
Kind of timber	Fir.
Cost of timber	$20 per thousand.
Length of road built	1 mile.
Character of ore	Quartz, with sulphurets.
Number of men in mine	4
Average wages in mine	$50 per month and board.

TRINITY MINE.

This property is situated in the Dog Creek Mining District, eight miles west of the town of Delta; located in 1886. The course of vein is east and west, its position being nearly perpendicular. Average width about five feet. The claim is one thousand five hundred feet by six hundred feet. Length of ore shoot has not as yet been ascertained. Development work consists of a tunnel one hundred feet in length, giving a vertical depth of sixty feet. The formation of both walls is porphyry. Eight miles of wagon road have been built.

Altitude	1,050 feet.
Length of ore shoot	Not determined.
Vertical depth reached from surface	60 feet.
Character of hanging-wall	Porphyry.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	50 pounds per month.
Cost of mining	50 cents per ton.
Cost of tunnel	$4 per foot.
Number of feet timbered	100
Kind of timber	Fir.
Cost of timber	$15 per thousand.
Length of road built	8 miles.
Character of ore	Quartz, with sulphurets.
Number of men in mine	7
Average wages	$2 50 per day.

LUCKY BART MINE,

Located September 30, 1887, lies sixteen miles west of the town of Delta, in the Stacey Mining District. The course of vein is northwest and southeast; dip, 80 degrees to the southwest. The vein is about two feet wide. Developments on the property consist of a tunnel one hundred feet in length, reaching a vertical depth of seventy-five feet; also a vertical shaft twenty-five feet deep. Formation of both walls is porphyry. The claim is one thousand five hundred by six hundred feet. The ore here was very rich from surface to bottom of shaft; a portion of the ledge was worked by pan, and yielded, it is said, $4,000.

Altitude	1,150 feet.
Length of ore shoot	Not determined.
Depth of ore shaft vertically	25 feet.
Vertical depth reached from surface (by tunnel)	75 feet.
Character of both walls	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	25 pounds per month.
Cost of mining	$3 per ton.
Cost of tunnel	$5 per foot.
Cost of shaft	$5 per foot.
Number of feet timbered	125
Kind of timber	Fir.
Cost of timber	$15 per thousand feet.
Number of men in mine	5
Average wages	$2 50 per day.

QUARTZ MOUNTAIN MINE.

This mine, which is situated in the Quartz Hill Mining District, five miles northwest from the town of Redding, was originally located about twenty years ago; relocated in 1884. The vein runs northeast and southwest, and dips 80 degrees to the south; average width, thirty-five feet. The claim is one thousand five hundred feet by six hundred feet, the ore shoot extending its whole length. Development work consists of a tunnel one hundred and seventy-three feet in length and a vertical shaft down sixty-one feet. Both walls are porphyry.

Altitude	750 feet.
Length of ore shoot	1,500 feet.
Depth of ore shaft vertically	61 feet.
Vertical depth reached from surface (by tunnel)	75 feet.
Character of hanging-wall	Porphyry.
Character of foot-wall	Porphyry.
Kind of powder used	Safety Nitro.
Quantity of powder used	100 pounds per month.
Cost of mining	25 cents per ton.
Cost of tunnel	$25 per foot.
Cost of shaft	$1 per foot.
Character of ore	Quartz, with sulphurets.
Number of men in mine	6
Average wages	$2 50 per day.

WEST POINT MINE,

Located February, 1886, is situated in the Middletown Mining District, seven miles west of the town of Redding. The course of vein is northeast and southwest. The claim is fifteen hundred feet by six hundred feet. Vein dips 60 degrees to the north; average width, eighteen inches; length of ore shoot not determined. Developments consist of a tunnel fifty-five feet in length, and an incline shaft thirty-eight feet deep. Vertical depth from surface reached is seventy-five feet. The formation of both walls is porphyry.

Altitude	750 feet.
Length of ore shaft on incline	38 feet.
Depth of ore shaft vertically	32 feet.
Vertical depth reached in mine (55-foot tunnel)	75 feet.
Character of walls	Porphyry.
Kind of powder used	Safety Nitro.
Quantity of powder used	10 pounds per month.
Cost of mining	$3 per ton.
Cost of tunnel	$5 per foot.
Cost of shaft	$10 per foot.
Number of feet timbered	93
Kind of timber	Pine.
Cost of timber	$20 per thousand.
Character of ore	Quartz, with sulphurets.
Number of men in mine	3
Average wages	$2 50 per day.

EUREKA MINE.

This property is situated in the Lower Springs Mining District, two and one half miles west from the town of Redding; located March, 1884. Course of vein is northeast and southwest; supposed length of ore shoot, five hundred feet. The claim is one thousand five hundred feet by six hundred feet. Width of vein is reported to be four feet in the bottom of the shaft, which, being full of water, the statement could not be verified. Development work consists of an incline shaft down ninety-eight feet, giving a vertical depth of seventy-four feet. Hanging-wall, slate; foot-wall, porphyry. Exceedingly rich ore was found near the surface of this claim.

Altitude	750 feet.
Length of ore shoot (supposed)	500 feet.
Length of ore shaft on incline	98 feet.
Vertical depth reached in mine	74 feet.
Quantity of water raised in twenty-four hours	20 barrels.
Character of hanging-wall	Slate.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	15 pounds per month.
Cost of mining	$3 per ton.
Cost of shaft	$10 per foot.
Number of feet timbered	98
Kind of timber	Pine.
Cost of timber	$20 per thousand.
Length of road built	500 feet.
Character of ore	Quartz, with sulphurets.
Value of sulphurets per ton	$300
Number of men employed	2
Average wages	$2 50 per day.

WHITE OAK MINE.

This prospect is situated in the Lower Springs Mining District, two and one half miles northeast from the town of Shasta; located in 1882. The course of vein is east and west; dip, 40 degrees to the north. The average width of vein is about five feet. Dimensions of claim, one thousand five hundred feet by six hundred feet.

The supposed length of ore shoot is three hundred feet. The formation of both walls is porphyry. Development work done consists only of an incline shaft forty-five feet in depth.

Altitude	750 feet.
Length of ore shoot	300 feet.
Length of ore shaft on incline	45 feet.
Vertical depth reached in mine	40 feet.
Character of hanging-wall	Porphyry.
Character of foot-wall	Porphyry.
Kind of powder used	Giant.
Quantity of powder used	25 pounds per month.
Cost of mining	$1 25 per ton.
Cost of shaft	$7 per foot.
Number of feet timbered	45
Kind of timber	Pine.
Cost of timber	$20 per thousand.
Character of ore	Quartz, with sulphurets.
Percentage of sulphurets	2
Number of men in mine	3
Average wages	$2 50

EMIGRANT MINE.

This property is situated in the Grizzly Gulch Mining District, six miles north from the town of Stella; located January, 1886. The course of vein

is north and south; dip, 80 degrees to the east. The average width of vein is three feet. Length of ore shoot is two hundred feet. Development work consists of a tunnel run on the vein four hundred feet in length, giving a vertical depth of one hundred and sixty feet. Formation of hanging-wall, slate; foot-wall, porphyry.

Altitude	1,500 feet.
Length of ore shoot	200 feet.
Vertical depth reached from surface	160 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Porphyry.
Kind of powder used	Giant
Quantity of powder used	25 pounds per month.
Cost of mining	$2 per ton.
Cost of tunnel	$4 per foot.
Kind of timber	Pine.
Cost of timber	$20 per thousand.

LIMESTONE QUARRY.

Half a mile northwest from Kennet Station, on the line of the California and Oregon Railroad, is situated Kennet Lime Rock Quarry. The deposit is two miles in width, and about five miles in length. The lime has been in use for the past four years in the construction of buildings, both in Redding and Red Bluff. It is also used by the California and Oregon Railroad Company in finishing the hotel buildings along the line of road, and is considered a very superior quality.

Reported Analysis.

Carbonate of lime	95.2
Silica	4.4
Magnesia	.5
Carbon (organic)	Trace.
Total	100.10

SANDSTONE.

Situated six miles northeast from the town of Redding occurs what seems to be an inexhaustible deposit of sandstone. All of the culverts built by the California and Oregon Railroad Company in Shasta County were constructed from this stone. Contractors are using it largely in the new buildings now being erected in Redding. This stone is quite soft when taken from the quarry, but hardens on being exposed to the air.

Reported Analysis.

Water at 300° F.	6.20
Sand	85.21
Silica	1.58
Alumina and iron	6.30
Lime	.51
Total	99.80

SIERRA COUNTY.

This county derives its name from the Sierra Nevada (snowy range of mountains), which occupies the whole of its upper eastern half. Sierra is bounded by Plumas and Lassen Counties on the north, the State of Nevada on the east, Nevada County on the south, and by Yuba and Plumas Counties on the west. This is one of the most elevated and rugged counties in the State, its altitude ranging from three to eight thousand feet above tide water. The face of the county is everywhere eroded by cañons, some of them more than two thousand feet deep. Standing to the west of the main Sierra are a number of isolated peaks, the most conspicuous of which are the Downieville Buttes, oftener called the Sierra Buttes, eight thousand three hundred feet in height; Table Mountain, in the western part of the county, over six thousand feet high; with Saddle Mountain lying a little to the south and nearly as high.

The principal streams in Sierra consist of the North and Middle Forks of the Yuba River, the former running centrally through the county, and the latter forming in part its southern boundary. The numerous confluents of these streams and of the Feather River, which has its principal sources in Sierra County, make this one of the best watered counties in the State. On or near the summit of the Sierra, where the range spreads out into flats and valleys, occur numerous small lakes, most of them circular in form. These lakes vary from one eighth of a mile to three or four miles in length, most of them, considering their small size, remarkable for their great depth. One of those bodies of water, known as Gold Lake, is notable as having been the locality of a gold excitement as early as the summer of 1849. While the rumor of rich diggings having been found on the borders of this lake obtained currency at the period mentioned, the stampede that made the event memorable did not occur until the following year. Gold Lake, which is about four miles long and two wide, is the source of the Middle Fork of the Feather River.

Sierra, like Plumas County adjoining it on the north, is covered with magnificent forests of yellow pine, red spruce, fir, cedar, and sugar pine, intermixed with oak of several varieties at lower altitudes. These forests are somewhat scattered in the western part of the county, but increase in density as altitude is gained, the trees standing tall and thick on the very summit of the Sierra.

While Sierra is essentially and almost wholly a mining county, fruits and vegetables of the hardier kinds are everywhere raised in abundance. In the small mountain valleys and flats some grain and the cultivated grasses are grown, these localities abounding also with wild clover. Much stock is kept here, more especially cows, dairying being carried on largely.

QUARTZ MINING AND MILLING.

SIERRA BUTTES MINE.

The report of the State Mineralogist for 1886, Part II, contains a brief notice of this mine, a part of which is here transcribed: "This property, in the Sierra City Mining District, is situated on the southern slope of the Sierra Buttes Mountain, whose peaks rise four thousand seven hundred feet above the lower works, and eight thousand eight hundred feet above the sea level. The altitude of the croppings is six thousand four hundred feet, and that of the lower tunnel is four thousand one hundred feet.

The dimension of the claim is eleven thousand feet in length by six hundred feet in width. The vein has a general east and west direction, with a dip to the north of 41 degrees, and averaging in width twenty feet. Work was first begun on the mine in 1850, and has been unremitting in dividends up to the present date. * * * The water supply, drawn from several lakes, is brought around the mountain side, a distance of seven and half miles, in flumes to the mine. The main flume, seven miles in length, is fed by several tributaries, which tap the sources of supply. * * * The property is now, and has been since 1870, owned and worked by an English company. The mine is worked through a series of nine tunnels."

The company has also constructed nine miles of road for the transportation of ores, timber, fuel, etc. Since the date of the report quoted, the tunnels in this mine have been advanced as follows: No. 6, three hundred and fifty feet; No. 7, not any; No. 8, nine hundred feet; No. 9, one thousand seven hundred feet; Nos. 6, 8, and 9, are still being driven ahead. The mine is less prosperous now than formerly. Tunnel No. 9 has been a failure so far, and no stoping is done in it; stoping continued between Nos. 8 and 7. The vertical depth now reached is two thousand two hundred feet from the surface above the face of Tunnel No. 9, which is equal to more than three thousand feet on the vein. The walls in Tunnel No. 9, at seven thousand feet from the entrance, are, on the hanging side, metamorphic talco-siliceous slate, and on the foot-wall metamorphic calcareous slate. The entire length of tunnel, except about eight hundred feet, is timbered with fir, costing 9 cents per running foot for round logs of eighteen inches average diameter.

The ore is extracted at a cost of $3 54 per ton, including dead work, and is treated by wet stamping, amalgamation, and concentration. It consists of quartz with free gold, and about six tenths of 1 per cent of sulphurets consisting of pyrites with a little galena and blende, the concentrations assaying about $97 per ton in gold, and $3 per ton in silver; the yield of free gold from the rock is not given. The concentrates are treated by chlorination at the company's works at a cost of $16 per ton, including the expense of concentration, which, considering the low percentage of sulphurets in the ore, is probably in the neighborhood of $10 per ton of concentrates, leaving about $6 per ton for the actual expense of the extraction of the gold, consequently the stated cost of milling, namely, 34½ cents per ton, does not include the concentration. The proportion of the gold saved from the concentrates is 93 per cent of the assay value. The assays of mill tailings indicate that about 76 per cent of the value of the ore as it comes from the mine remains in the mill as amalgam and concentrates, which, considering that the ore now being worked is of such low grade that the arrastra men will not touch the tailings, may be regarded as a good result; for these men say that when the ore pays as much as $5 per ton in the mill, it will pay to take up the tailings and regrind them in water-arrastras. But although there are several arrastras in operation here, they are working on a lot of old tailings and not of recent production.

The principal mill has sixty stamps of eight hundred and fifty pounds each, dropping eight inches eighty-six times per minute and crushing two and four tenths tons of ore to the stamp in twenty-four hours, through No. 7 slot-punched screens, having a discharge surface to each battery of five stamps, forty-eight inches in length by eight inches in height, set vertically. The shoes are of steel, costing 7½ cents per pound; the dies of cast-iron, at 4½ cents per pound. A shoe weighs one hundred and fifty pounds and lasts one hundred days. A die weighs one hundred pounds and lasts

forty-five days. The consumption of steel per ton of ore crushed is therefore six hundred and twenty-five thousandths of a pound, costing 6.56 cents per pound. The consumption of iron dies per ton is nine hundred and twenty-six thousandths of a pound, nearly, costing 4½ cents per pound. It is not to be inferred that iron is cheaper than steel, because the shoe necessarily wears more than the die, which is partly protected by a layer of ore. The total cost for shoes and dies is 11.06 cents per ton of ore crushed, which, however, may be reduced in this case for the value of the residues, amounting to 20 per cent of the weights, which bring 2 cents per pound as old iron. This leaves the actual expense for shoes equal 6.31 cents, and for dies, 4.13 cents; total, 10.44 cents per ton of ore.

There are no aprons in the usual meaning of the term; instead, there is a lip-plate on the mortar, which is four feet in its larger dimensions by one foot in the shorter. The pulp, passing through the screen, flows on this plate and into a cast-iron trough about one foot wide by four feet long, extending across the front of the mortar, under the lip, and attached to the mortar by flanges and bolts. The bottom of the iron trough is inclined in the direction of its length, that is, toward one side of the mortar, at such an angle as to cause the pulp to flow that way and to pass through a port in front of the trough, into a distributing box and thence through holes into the plated sluice, which is fifteen inches wide and twenty feet long. Each battery of five stamps is thus arranged, accounting for the "total length of plates in feet, two hundred and forty," as given in the report of 1886. The usual style of apron was tried and discarded, as it was found that so large a surface could not be kept in good condition. The present arrangement has the advantage of leaving the front of the mortar easily accessible.

It is a singular fact, and one which calls for investigation, that silvered plates cannot be used in this mill, as the silver comes off so soon that the cost of such frequent replacing would be too great; while on the other hand, silvered plates are considered to be indispensable in the twenty-stamp mill of the same company, of which mention is made in another place. The only difference known, as to the two cases, is, that this mill (the lower) is crushing ore from the deep workings of the mine, containing a small percentage of sulphurets, while the upper mill treats surface ores with no sulphurets. Inside plates are used in the mortars. The back plates are three inches high and as long as the mortars; the plated "chuck-blocks" in front are about six inches high, the foot rails of the screen frames being eight inches high and the screen surface the same. This leaves the top rail of the screen frame below the top of the opening in the front of the mortar by a space of about three inches, through which a view can be had of the interior of the mortar at any time, a very good arrangement, because it sometimes happens in a mill, that a shoe becomes detached and remains vertically in place in the mortar, allowing the boss to slip over the shank at every stroke, and thus the stamp continues dropping to the full extent; and the only indication of the accident is the sound of metallic contact, which, in one stamp among sixty, might escape the notice of the attendant for some time, leading to the ruin of the boss, as well as wasting the time of the stamp. Eighty per cent of the recovery of free gold is saved in the batteries, and 20 per cent on the plates. An iron barrel, supplemented by an automatic "batea," also of iron, and carrying three cannon balls, is used for cleaning amalgam.

The quantity of water used in the batteries is not measured. The loss of quicksilver per ton of ore worked is not given, but is much greater in

the lower than in the upper mill, probably from the same causes that led to the observed difference in the action of the plates. There are twenty-four Frue vanners in the mill, using in all four inches of water measured under six inches of pressure.

The company's other mill of twenty stamps on the mountain is employed in working old dumps and surface rock, at a cost of 75 cents per ton all told. The fifty-stamp mill, mentioned in the report of 1886, was burned in 1887, and the present twenty-stamper was erected near its site at a cost of $3,000, the stamps, mortars, and other available parts of the burned mill being utilized as far as possible.

In the chlorination works there is nothing unusual to note, except that owing to complaints of the effect of the fumes from the roasting ore on vegetation in the neighborhood, steps were taken to abate this annoyance as follows: The smoke and fumes from the furnace, instead of being allowed to escape at the top of the stack, are drawn through an iron flue, and afterwards forced through an earthen flue by means of a "water blast," consisting of a jet from a quarter inch nozzle under five hundred and thirty feet fall. After passing through sixteen feet of the earthen flue, the fumes, with the water from the jet, goes down a vertical flue about twenty-two feet; through this flue also flows a stream of about ten inches of water in the form of a shower. The water and such portion of fume as is not yet absorbed, now traverse a nearly horizontal wooden conduit or pipe, about one hundred and twenty feet, to another short fall, where still another shower of water falls with it, and this is succeeded by another horizontal flue. When the final exit is reached only a slight smell of sulphur can be perceived in the escaping steam and gases.

The roasting furnace is a long reverberatory with several hearths. The total dimensions are fifty feet long by twelve feet wide inside. The capacity is two tons of concentrates roasted in twenty-four hours, with a consumption of one half cord of pine wood per ton of ore, at $4 25 per cord.

The entire establishment is furnished with incandescent electric lights, for the production of which a Knight wheel of eight feet diameter is employed, while the batteries and Blake rock breakers, of which latter there are three, are worked by means of a Pelton wheel of six feet diameter under five hundred and thirty feet fall. The concentrators are operated by another Pelton wheel of three feet diameter under the same pressure, and a six-foot Pelton, with sixty feet of pressure, pumps the "hypo" in the chlorination works for the leaching of the small quantity of silver which the concentrates contain. The air compressor used in this mine is the National, and the powder is stated to be "a nitro glycerine compound," of which the monthly consumption amounts to one ton.

Altitude of croppings	6,400 feet.
Altitude of lower tunnel, No. 9	4,100 feet.
Length of Tunnel No. 6	5,200 feet.
Length of Tunnel No. 7	5,050 feet.
Length of Tunnel No. 8	6,100 feet.
Length of Tunnel No. 9	8,900 feet.
Vertical depth from surface reached	2,200 feet.
Kind of compressor used	National.
Kind of powder used	A nitro glycerine compound.
Quantity of powder used	2,000 pounds per month.
Cost of running Tunnel No. 9	$12 per foot.
Dimensions of Tunnel No. 9	7 feet high; 9 feet wide.
Number of feet run per day at present	2
Cost of mining ore, including dead work	$3 54 per ton.
Length of tunnels timbered	All but 800 feet.
Kind of timber used	Fir.
Cost of timber	9 cents per running foot for round, averaging 18 inches in diameter.
Distance of mine from timber	8 miles.

Length of road built by company	9 miles.
Length of ditch and flume	7 miles.
Number of stamps working	In lower mill, 60; in upper mill, 20; total stamps, 80.
Weight of stamp	850 pounds.
Drop of stamps	8 inches.
Drops	86 per minute.
Duty per stamp	2.4 tons in twenty-four hours.
Kind of shoes used	Steel.
Kind of dies used	Iron.
Cost of shoes	7½ cents per pound.
Cost of dies	4½ cents per pound.
Weight of shoe	150 pounds.
Weight of die	100 pounds.
Life of shoe	100 days.
Life of die	45 days.
Cost of shoes per ton of ore crushed	6.31 cents.
Cost of dies per ton of ore crushed	4.13 cents.
Cost of shoes and dies per ton of ore crushed	10.44 cents.
Kind of screens used	Slot punched, No. 7.
Dimensions of discharge surface of screen	48 by 8 inches.
Dimensions of lip plates in mortars	48 by 12 inches.
Width of plated sluices	15 inches.
Length of plated sluices to each battery	20 feet.
Kind of breakers used	Blake.
Kind and number of feeders used	Hendy, 16
Kind and number of concentrators used	Frue, 24
Water used in twenty-four concentrators	4 inches.
Percentage of sulphurets saved from ore	Six tenths of 1 per cent.
Value of sulphurets per ton	Gold, $100; silver, $3; total, $103.
Method of treating sulphurets	Chlorination.
Percentage of value saved from sulphurets	93
Cost of working sulphurets, including concentration	$16 per ton.
Dimensions of roasting furnace	12 by 50 feet.
Capacity of roasting furnace	2 tons in twenty-four hours.
Consumption of fuel in roasting	¼ cord per ton.
Cost of fuel for roasting (pine)	$4 25 per cord.
Percentage of recovery of free gold saved in batteries	80
Percentage of recovery of free gold saved on plates	20
Total number of men employed	209
Average wages paid, with board	$50 per month.
Number of Pelton wheels used	3
Number of Knight wheels used	1
Fall of water for power	60 and 530 feet.

THE YOUNG AMERICA MINE.

This property is located in Sierra City Mining District, seven miles north of Sierra City, at an altitude of seven thousand two hundred feet. The claim is six thousand feet in length and five hundred feet in width. The vein has an easterly and westerly course, dipping to the north at an angle of about 45 degrees, and averages six feet in width. The formation of the hanging-wall is diabase; foot-wall, slate. The mill site is located three thousand two hundred feet from the mine, giving about one thousand feet perpendicular height from the mill to the croppings. The ore is conveyed to the mill by a tramway, in cars containing one ton each of ore, this structure doing away with the troublesome elevated tramway previously in use, and reducing the expense of conveyance. The mine is now opened by three tunnels, Nos. 1, 2, and 3. No. 1 follows the vein through the mountain to the other side, where the timber is located, a distance of one thousand three hundred and fifty feet; No. 2 tunnel is run in a distance of two thousand two hundred feet; No. 3 is one thousand six hundred and fifty feet in length, and will be continued to a distance of five thousand two hundred and eighty feet; No. 3 tunnel gives eight hundred feet reserves on the dip of the vein, up to No. 2, with a pay shoot eight hundred feet in length. No. 4 tunnel will be commenced on a level with the mill this season and be run by power drills. The water power consolidation contains

four lakes; the small lake, three quarters of a mile below the mill, is used to hold the tailings, the higher lake, directly under the snow-capped buttes, feeds the waters of the melting snow to the reservoir which furnishes the mill with power.

Altitude	7,200 feet.
Number of stamps	40
Weight of stamp	750 pounds.
Drop of stamps	7 inches.
Drops	80 per minute.
Duty of stamps	80 tons in twenty-four hours.
Average width of vein	6 feet.
Size and character of screens	No. 7 slot.
Width of apron plate	48 inches.
Width of sluice plates	15 inches.
Water used	30 inches per day.
Pressure of water	230 feet.
Cost of mining	$2 per ton.
Cost of milling	75 cents per ton.
Percentage of recovery saved in batteries	75
Percentage of recovery saved on plates	25
Number of men in mine	60
Number of men in mill	10
Total number of men employed	125
Length of tunnels	No. 1, 1,350 feet; No. 2, 2,200 feet; No. 3, 1,650 feet.
Length of ore shoot	800 feet.

THE RAINBOW MINE.

This mine, which is located in Chipps Flat District, at an altitude of three thousand eight hundred feet above sea level, is opened by a tunnel two thousand three hundred feet long, with an upraise of four hundred and thirty-one feet, connecting with an upper tunnel and old works. Fifteen hundred feet from the mouth of the lower tunnel a turn is made, following the back ledge. Two hundred and four feet from the turn in main tunnel the pay shoot was struck, and is being followed to get under the old works, from which $300,000 was taken. The ore is found in bunches and short shoots. The sulphurets, arsenical and iron pyrites, are saved on Frue concentrators, and run from 1½ to 2½ per cent, having a value of $80 per ton. The hanging-wall is slate, and the foot-wall is serpentine. The course of the vein is southeast and northwest, dipping to the north about 60 degrees, with an average width of about three feet. Vertical depth from surface reached in lower tunnel is about seven hundred feet. Size of claim, seven thousand three hundred and sixty-five feet in length by four hundred feet wide. Water for mining and milling purposes is conducted through three hundred feet of flume, fourteen by twenty-eight inches, carrying three hundred inches of water, with a pressure of one hundred feet, which produces sufficient power, through the aid of two Pelton wheels, to run a Richmond compressor, two Ingersoll drills, and the ten-stamp mill.

Altitude	3,800 feet.
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamps	7 inches.
Drops of stamps	85 per minute.
Duty of stamps	28 tons in twenty-four hours.
Shoes and dies	White iron.
Cost of shoes and dies at mill	5 cents per pound.
Screens	No. 40, round punched.
Size of apron plate	4½ by 5 feet.
Length of sluice to each battery	12 feet.
Feeders	Hendy Challenge.
Concentrators	Frue, 4
Number of men employed when mill is running	27
Average wages paid	$3 per day.

RISING SUN MINE.

This property is situated in the Alleghany Mining District, at an altitude of four thousand seven hundred feet above the level of the sea. The course of the vein is north and south, and dipping to the west at an angle of 80 degrees, and has an average width of four feet. Dimensions of claim are two thousand five hundred feet by six hundred feet. The length of ore shoot is six hundred feet, and the ore is free milling, containing 1½ per cent of sulphurets, valued at $100 per ton. The developments consist of three tunnels following the course of the vein. No. 1 tunnel is in one hundred and twenty feet, No. 2 is in one hundred and forty feet, and No. 3 is in one hundred feet; the latter reaches a vertical depth of four hundred and seventy-five feet on the vein.

THE EAGLE MINE

Is located in the Chipps Flat Mining District, at an altitude of four thousand four hundred feet above sea level. The course of the vein is north and south, dipping to the east, with an average width of three feet, and carries 2½ per cent of sulphurets. Dimensions of the claim are one thousand five hundred feet in length by six hundred feet wide. The length of the pay shoot exposed is three hundred feet, and still in ore. The mine is opened by tunnel, following the vein three hundred feet in length, which reaches a vertical depth of one hundred feet from the surface. The hanging wall is syenite, and the foot-wall is serpentine. The company stoped three hundred tons of quartz, which milled an average of $30 per ton. This property can be worked by water power, both for milling and mining, by running a tunnel from the creek below, where at least five hundred feet of reserves can be had. The company propose putting up a ten-stamp mill at an early day.

THE MYRTLE MINE

Is located in the Downieville Mining District, at an altitude of three thousand five hundred feet above sea level. The course of the vein is northwest by southeast, dipping to the north at an angle of 60 degrees, having an average width of three feet, inclosed between a serpentine hanging-wall and a slate foot-wall. At a depth of forty feet from the surface, or from where the vein was exposed by hydraulicking, a tunnel was run at right angles to the vein, which it reached at a distance of fifty feet. A drift run north on the vein one hundred feet, exposed rich quartz and a good pay shoot all the way.

GOLD BLUFF MINE

Is located one and one half miles north from the town of Downieville, on the North Fork of the Yuba River, at an altitude of three thousand two hundred feet above the sea. Extent of claim, four thousand five hundred feet by six hundred. Course of vein north and south, with a dip to the west at an angle of 45 degrees; hanging-wall, porphyry; foot-wall, slate. Average width of vein three feet on the north ledge, and a pay shoot fifty feet in length so far as exposed, and still in ore. The west ledge averages four feet in width with a pay shoot one hundred feet in length and still in ore. The mine is worked through a tunnel two thousand feet in length, which gives a vertical depth of nine hundred and fifty feet from the surface. The west ledge was discovered by crosscutting, and has added greatly to the value of the property. The twelve-stamp mill, four stamps to battery,

is run by water delivered on an overshot wheel. This claim was located in 1851, and has been worked with but a few intermissions since that time. The ore is free milling and the result of five hundred tons crushed in the month of May, 1888, gave an average of $22 per ton.

The owners of this property contemplate increasing their plant to a forty-stamp mill in the near future. There is abundance of water for all power necessary. The ore contains from 3 to 4 per cent of sulphurets, valued at $200 per ton, saved at present by the old rocker process.

Altitude	3,200 feet.
Length of ore shoots (two)	50 and 100 feet.
Vertical depth from surface reached by tunnel	950 feet.
Cost of mining and milling	$2 50 per ton.
Number of stamps	12
Weight of stamp	650 pounds.
Drop of stamps	6 inches.
Drops of stamps	60 per minute.
Duty of stamp	1 ton in twenty-four hours.
Size of screen	Slot, No. 6.
Dimensions of apron plate	4 by 6.
Width of sluice	12 inches.
Length of sluice	36 feet.
Kind of feeder	Hand.
Shoes and dies	White iron.
Percentage of sulphurets	3 to 4.
Value of sulphurets	$200 per ton.
Number of men in mill	5
Number of men in mine	13
Total number of men	18
Average wages	$3 per day.

BUFFALO MINE.

Location, Hog Cañon District, nine miles northwest from Sierra City. Altitude, four thousand eight hundred feet above sea level. Course of vein, northeast and southwest, dipping west. It is very straight, has an average width of twentv feet, and carries about 2 per cent of sulphurets. Dimension of claim, four thousand five hundred feet by six hundred feet, consisting of three locations of one thousand five hundred feet by six hundred feet. The length of the pay shoot exposed is four hundred feet, and is still in ore. There is a shaft fifty feet in depth on the vein. The length of tunnel is four hundred feet, following on the vein. Vertical depth from surface reached in No. 2 tunnel, five hundred feet. Formation of walls: Hanging wall, porphyry; foot-wall, slate. Timber for all mining purposes is on the company's ground

The ore, which is free milling and partly honey-combed, has a value of $30 per ton. The company proposes erecting a mill the coming season, to be run by water power.

DRIFT MINES.

BALD MOUNTAIN EXTENSION CLAIM.

This property, located near Forest City, at an altitude of four thousand seven hundred feet above the sea, comprises an area of eight hundred acres, traversed by an ancient river channel, which here bears north 30 degrees east. Length of tunnel, eight thousand feet; cost, $6 per foot. The depth of gravel drifted is three feet. The pay per carload of one ton varies from $1 to $3. One man will take out about six carloads per day on the average. Sixty men are employed. Wages, $3 per day. Gross product from $6,000 to $20,000 per month. This claim has been worked to great disadvantage owing to the great length of the tunnel, supplemented by an incline of

thirty feet, through which the work of development and gravel extraction had to be carried on. On reaching the mouth of the tunnel, the gravel is washed in sluices. This company has paid dividends from February 19, 1884, to April 9, 1888. Total amount of dividends paid per share to date is $3,525, on a basis of twenty shares in the company. Total amount disbursed as dividends, $70,500.

A new tunnel is being run from the north side of the ridge, or Mammoth Springs side, which will reduce the expense of the company in mining the gravel and transporting the same to the sluices for washing fully one half of the former cost.

SOUTH FORK MINE.

This property, which consists of twenty claims of two hundred feet each, is located near Forest City, at an altitude of four thousand six hundred feet above sea level. The channel here courses southeast, and has been opened by a tunnel two thousand four hundred feet in length. An air shaft extends to the surface, a distance of one hundred and eighty feet. Cost per foot for tunnel, about $6. The pay gravel drifted is about four feet deep; value from $1 to $5 per carload, about five carloads per day per man being taken out. The width of the channel is about six hundred feet from rim to rim. At present the company has six men, at $3 per day each, running the main tunnel ahead.

ECONOMIC MINERALS.

Besides gold-bearing quartz veins, drift diggings, and other forms of auriferous deposits, Sierra contains silver, copper, and iron ores, the latter occurring at Gold Valley in quantities and of very superior quality, the conditions here being at the same time extremely favorable for large and cheap production. The only obstacle to the manufacture of iron at this point on an extended scale is the cost of transportation to market, the locality being in the mountains and a long distance from any railroad. While this iron ore, of which thousands of tons are in sight, has been tested and its excellence fully established, not enough has been done with the silver and copper deposits found in this county to determine either their extent or value.

CAMPBELL HOT SPRINGS.

These springs, three in number, are situated one mile from the town of Sierraville, at an altitude of five thousand and twenty-five feet above the level of the sea. One of these springs is cold, the other two have a temperature of 104 degrees Fahrenheit. They occur in a volcanic district, and the waters, which are sulphureted, are said to be efficacious in the treatment of kidney diseases, rheumatism, etc. Visitors are numerous here during the summer, there being a good hotel at the place with facilities for bathing.

SISKIYOU COUNTY.

Siskiyou County lies between the parallels 41 and 42 degrees north latitude, and 121 and 124 degrees west longitude. It is the central of the three most northerly counties of the State, bounded on the east by Modoc County, on the south by Humboldt, Trinity, and Shasta Counties, on the west by Humboldt and Del Norte Counties, and on the north by the State of Oregon.

It contains within its boundary lines three thousand and forty square miles of territory, a very small portion of which is arable. A large area, comprising thirty-four townships, designated on the maps as the Lava Bed Road District, and situated in the extreme northeastern portion of the county, adjoining Modoc, is, as its name implies, covered with lava and unfit for cultivation. The remainder, about two thirds of the whole, is mineral land, and here the various kinds of gold mining—quartz, placer, drift, and river—that exist in California, are prosecuted.

This corner of the county includes a small portion of the lacustrine system of the State; and the areas of water designated as the Lower Klamath and a portion of Tule Lake, with several of smaller dimensions, in the aggregate cover one hundred square miles of surface.

THE RIVER SYSTEM.

Siskiyou is abundantly supplied with perennial streams and living springs. Two of California's most important rivers take their rise in this and the adjacent County of Modoc. The main stream of the Sacramento, and also the Shasta River—a tributary to the Klamath—head in Mount Shasta, and diverge at that point, the Sacramento flowing southeasterly, and the Shasta northerly till it unites with the Klamath, a rapid and torrential stream, to the volume of which the Scott, Salmon, Trinity, and many other smaller rivers and creeks contribute. The Klamath is described at length elsewhere in this report. Some three hundred Indians live upon the banks of this important river, taking the tribal name from it, and obtaining their food chiefly from its waters, using the dip net and triangular seine to capture the salmon and other food fishes. Extensive land slips from the steep mountain sides in the vicinity are of frequent occurrence. Here mountains are covered with a dense growth of tall symmetrical trees. All varieties of the pine family are represented, including the valuable sugar pine, as well as oak, chestnut, ash of a superior quality, and madrona of large size, suitable for the cabinet-maker. The forests abound in bear, deer, grouse, and quail.

GEOGRAPHICAL AND TOPOGRAPHICAL FEATURES.

At an elevation of from fifty to five hundred feet a succession of terraces, or benches, occurs of considerable width, covered with forest trees and shrubbery, and containing auriferous gravel banks, which range from fifty to two hundred feet in height. These benches are frequent and are miles in extent. Their general trend is parallel with the course of the Klamath, but often cut by the more modern and deeper channel, and seen on the opposite banks at the same elevation. They are traceable the entire length, not only of the Klamath, but of all its noted tributaries. That they have not worn away gradually is proved by the rim rocks remaining intact and sharply defined. This condition of affairs has either been made by some sudden convulsion of nature, or by glacial action filling the bed of the river and forcing it to make a new channel, which has found lower levels. Possibly the latter theory may be the true one, as evidences of glacial erosion can be seen on many of the harder rocks. The gravels in these old channels form the most important class of mining in Siskiyou County, especially as the supply of water, with heavy pressure-heads, is abundant in the numerous creeks, ravines, and gulches that feed the main river. These minor streams seldom exceed twenty miles in length.

This county is *sui generis*. It has no counterpart on the Pacific Slope. Within its borders are found valleys and plains of arable land at an elevation of from two thousand five hundred to four thousand feet, surrounded by beetling cliffs and serrated ridges that rise from five hundred to nine hundred feet above sea level.

Scott Valley is situated near the central portion of the county at an elevation of three thousand feet. Twenty miles from Mount Shasta this valley is forty miles long by six miles in width, or about two hundred and forty square miles in all. Etna, its principal town, is at the head of the "wagon-road navigation." From this point supplies are sent by pack animals to the Salmon and Klamath regions. A short line (six miles) of railroad is in progress of construction from Montague Station, on the line of the California and Oregon Railroad, to Yreka, the county seat, which, when completed, will be the terminus of the railroad system in this county.

Volcanic cones are marked features in the landscape of Siskiyou. Mount Shasta, with its everlasting crown of snow, rises to an elevation of fourteen thousand four hundred and fifty feet above the ocean level, and others of lesser note lift their heads skyward. In this county, particularly in the Klamath, Salmon, and Scott Ranges, mountains lose their smoothly-rounded summits. Table lands are seldom seen; sharp, serrated ridges have replaced them, with deep gorges and precipitous cañons. An important change is to be noted in the topographical features of this county. The Coast and Sierra Nevada Ranges are here merged into one. The strike, or trend, of the stratification has been changed from west of north to north 20 degrees east.

THE METALLIC WEALTH.

The formation and metalliferous belts of Siskiyou are not so clearly defined as in the middle and southern counties of the State, where they are easily traced for long distances. Sections taken from east to west, bisecting the formation, show the following results: The initial point being the westerly boundary of the lava-covered plains in Shasta Valley—T. 45 N., R. 5 W.—where a body of fossiliferous sandstone is exposed, taking a westerly direction, a place was reached in the vicinity of Shasta River, and near the line of the Oregon and California Railroad, where an artesian well had been bored, reaching a depth of six hundred and ninety feet. The borings showed alternate layers of soil, sedimentary volcanic ash, auriferous gravel, volcanic debris, sandstone, and, lastly, a bed of magnetic iron, particles of which adhered to the drill. The flow was one hundred and fifty thousand gallons daily. The water contained 4 per cent of chloride of sodium, some oil, accompanied by illuminating gas. Necessity for the well ceasing, it was plugged up and abandoned.

From this point westerly, crossing a valley covered with rich alluvial soil for a distance of three miles, sandstone was again encountered. Underlying this was a bed, from four to five feet, of bituminous shale, showing seams of lignite (coal) of good quality, dipping east at an angle of 8 degrees, and resting on a quartzite substratum, which formed the rim rock of the basin. But little development had been made on these coal seams, only an incline of from thirty to forty feet; after which the work was abandoned.

Following the quartzite in a westerly direction for about one mile, a belt of magnesian rocks containing iron ore is apparent. This formation continues for one mile and a half, when the main gold-bearing belt of the county is entered, consisting of metamorphic slates of the several varieties—crystalline, argillaceous, chloritic, and talcose, with, occasionally,

intrusive masses of porphyry, trap, and syenite. This belt is from five to ten miles in width, and about sixty miles long, widening and narrowing at places on its line of strike, which is north 20 degrees east. The erosion and decomposition of the belt has resulted in the formation of the rich placers of this portion of Siskiyou County. In some places it is veined and seamed with stringers of quartz; in others it is soft and friable, carrying talc in excess, with irregular bunches of quartz, rich in gold. It is also this class of deposits that forms the so called "seam diggings," worked by the hydraulic method. The material being soft and friable, stratification irregular, broken and reticulated, it readily crumbles before the force of a stream of water with a heavy pressure head. Mining in this way is, as a rule, profitable, though not rich enough for stamp work.

In other localities on the belt, where the formation has been fissured, or near the line of a contact, veins of quartz are found, singly and in groups; not large, generally speaking, but rich in gold. These veins are comparatively undisturbed. Few attempts have been made to develop them, owing to the heavy expense necessary. It took six months of time, at an enormous cost, to get the machinery of the Black Bear Mill, of thirty-two stamps, situated on the creek of that name, a tributary to the Salmon, in place and running. This auriferous belt has been cut longitudinally and transversely by torrential streams, which have worn deep channels in the mountain chain. Though Siskiyou's superficial and easily worked placers may be said to be nearly exhausted, there yet remain deeper beds of auriferous gravel and comparatively untouched veins of quartz awaiting capital and the hand of industry.

At a point southwesterly a short distance from what are called the "Pinery Placers," described elsewhere, Salmon Mountain intervenes, and has broken the continuity of the belt. It is largely composed of eruptive rocks, porphyries and granites, and seems to have been a disturbing element, as auriferous rocks do not come to the surface for about twelve miles beyond. Reaching as far as the known southerly limit of this gold-bearing belt extends, and crossing it, a narrow belt one mile and a half wide of argillaceous slate and porphyry is encountered, and then a decided belt of serpentine from four to six miles in width is entered, traceable for a long distance on its line of strike. At Scott's Bar a belt of micaceous schist is met with; and westerly from this point belts of granite, limestone, and syenite are alternately crossed, until another belt of auriferous slates is entered. Of this but little is known, as the region has been but slightly prospected.

Besides gold, other products of commercial value are found in the county, viz: platinum, silver, copper, cinnabar, plumbago, and antimony.

THE KLAMATH RIVER.

This river and its tributaries have been important agents in the distribution of gold throughout the county. The Klamath takes its rise in the high table lands and mountain ranges of Southern Oregon and Northern California, and where the lacustrine system of those regions is found. Upper Klamath, Lower Klamath, Goose, and Rhett Lakes, which are connected, give the river its source, and are the reservoirs from whence it draws the main volume of its waters. Its general course is 10 degrees south of west, till it disembogues into the Pacific Ocean at a point forming the western extremity of the dividing line between Del Norte and Humboldt Counties. The Klamath runs a tortuous course on its way to the ocean,

and bears to every point of the compass before it loses itself in the great sea. In the northern portion of Humboldt County the river plunges through box cañons miles in extent, and, emerging, becomes a broad sheet of water apparently currentless and smooth, but there is an undercurrent that renders this place dangerous to the bather. Rapids, whirlpools, and eddies mark its whole course after this brief repose. In no place and at no season of the year is the river practically navigable for vessels of any burden. During the freshet of 1862 its waters rose in one of the cañons to one hundred and two feet above low water mark. A rise from forty to fifty feet is not an uncommon occurrence. The Klamath is well stocked with several varieties of trout, and with salmon in their season. Its length, from the point where it crosses the north boundary line of California, at an elevation of four thousand three hundred and sixty-eight feet above ocean level, to its mouth, with contour lines, as given by the United States Coast Survey, is three hundred and sixty-two miles, its average grade being twelve feet to the mile. At Happy Camp, one hundred and thirty miles from this river's outlet, a rain gauge shows the precipitation to be for the past five years, as follows:

Years.	Rainfall —Inches.
1883 to 1884	$41\frac{5}{8}$
1884 to 1885	$41\frac{12}{100}$
1885 to 1886	$52\frac{3}{4}$
1886 to 1887	42
1887 to 1888	$50\frac{18}{100}$
A mean rainfall of $46\frac{3}{8}$ inches.	

CHINESE MINERS.

It is estimated that there are about one thousand Chinamen engaged as miners in this county, and the number is rapidly increasing. They may be found principally on the Klamath River and its tributaries, where lie the auriferous placers. Many of these people own the ground they work, more work as "tributers," paying a royalty to the owner of the claim, and a minority work by the day. Several shrewd wage-workers receive but small remuneration; their actual business on the ground is to spy out its value and report the same to their wealthier countrymen who deal largely in mining properties. The output of the claims owned by Chinamen cannot always be ascertained, as often the wily Celestial takes his own bullion to San Francisco and ships it thence to China direct. "John's" gold seldom appears tabulated in Wells-Fargo's statements, or in the annual statistics of the United States Branch Mint. Placing the average earnings of the Chinese at the low figure of $1 per day, it would make their yearly harvest from the gold gravels of this county $365,000; but this amount can, with safety, be quadrupled, as these people own and work some of the richest river claims in Siskiyou.

Mining Districts: Cottonwood, Yreka, Humbug, Deadwood, Oro Fino, Callahan's Ranch, Scott River, Oak Bar, Seiad Valley, Cottage Grove, Liberty, South Fork of Salmon, and Forks of the Salmon.

THE PLACER CLAIMS IN SISKIYOU COUNTY.

COTTONWOOD MINING DISTRICT.

Blue Gravel Mining Company.

The claim of this company is about two miles and a half from the town of Henley. It has an elevation above the Klamath River of some three hundred feet, and above the level of the sea two thousand five hundred and fifty feet. Located in July, 1867, the actual working has been only for six months, so far. The company hold nine hundred feet of the river channel; the entire area aggregates one hundred acres. The course of the lead is northwest and southeast; the nature of the pay gravel pebbly, not many bowlders, but some clay and cement are near the bedrock. It is worked by a tunnel which cost $2 per foot to run, passing through slate and blue gravel in its course. There are two working tunnels in the mine, No. 1 being one hundred and twenty feet in length, and No. 2 one hundred and eighty feet. Metamorphic slate is the character of the bedrock; the depth of gravel drifted is six feet, and it is sluiced after being taken out. Width of pay channel, from two hundred and fifty to four hundred and fifty feet. The mine having been worked only six months, is, of course, as yet only in progress of development. At present, it prospects from a color to $1 per carload of one thousand five hundred pounds. The usual quantity of timber (principally fir, and costing 5 cents per running foot) used in drift claims is needed here; the levels are timbered in sets, the breasts with single post and cap, which are withdrawn as the breast is pushed forward, the roof depending for support on pillars of rock thrown back. The timber is hauled a distance of from two to three miles. But few bowlders are met in the workings, and there is no water to contend with. Only four men are employed at present, in running drifts. They are paid at the rate of $45 per month.

Herzanger Placer Mine.

This is the next claim on the Klamath River, and three miles distant from the last mentioned. It is located on a riffle, or bar, with but a slight flow of water, and from eighteen to twenty inches of gravel cover the bedrock. Four hundred by one hundred and seventy-five feet of the river bed has been freed from water, for the most part, by wing and head dams. The ground is worked with the usual river mining machinery. Seven men engaged in the operation are reported to be making from $15 to $20 to the hand.

Chinese Workings.

Passing the mouth of Shasta River, southerly, a number of claims worked by Chinese may be noticed, but from these stolid and uncommunicative Celestials it is impossible to get any information in regard to the yield of the ground.

Humbug Fluming Placer Mine.

At the mouth of Humbug Creek, and due west from the mouth of Shasta River, at a short distance above the mouth of the creek, the claim known by the name given above is in full operation. It is worked in the old forty-nine style, the gravel being picked and shoveled into sluices, and the heavy bowlders moved aside by hand derricks. There is an abundance of water for power, but it is not utilized. The working of this claim is done only in the day time, and as it is an extensive one—thirty-eight acres, five of

which have been worked over—the auriferous resources cannot, by the present system, be exhausted for many years.

The nearest town to this claim is Yreka, the county seat. Frontage of the claim on Humbug Creek is five thousand feet; width of gravel, from rim to rim, four hundred feet; width of pay channel (the course being north 20 degrees east), two hundred feet; height of banks, forty feet; thickness of gravel, from the bedrock up, fifteen feet. The length of sluices is two hundred feet; the size, twelve by sixteen inches, and grade, six inches to a box of twelve feet. Block and slat riffles are used. The gravel is said to pay from $8 to $10 per day to the hand. In winter the top dirt is ground sluiced, and in summer bottomed up and washed. The character of the bedrock is metamorphic slate. The height of the dump above the creek bed is from twenty to forty feet. Very little black powder is used in operating this claim, Giant being preferred. About ten pounds of quicksilver is in use, of which there is very little lost during a season. In regard to water and the facilities for its supply, the following particulars are given: Length of flume, two hundred feet; size, twelve by twenty-four inches; length of ditch, two hundred feet; size, eighteen by thirty inches; grade of flume, four inches to the rod; grade of ditch, three inches to the rod; capacity of ditch and flume, four hundred miner's inches—the quantity of water used is sixty inches. The supply of water (taken from Humbug Creek) is unlimited in wet seasons; but in dry, there are from one hundred to two hundred inches. The water is owned by the Consolidated Mining Company.

This claim was located in 1861, consolidated in 1874, and has been worked regularly ever since. The number of men employed per day is eight, all part owners or their representatives. From $2,000 to $3,000 is said to be the gross product per month, and for the season from $16,000 to $24,000.

Pacific Placer Mine

Adjoins the northerly boundary of the last above described claim below and at the junction of Humbug Creek and Klamath River. It was located in 1863 as the "Seventy-six," and is said to have been worked profitably for four years, when the owners of the Humbug obtained an injunction for alleged interference with the dumpage and drainage of their claim, it being a prior location. The Pacific people discontinued work, and the ground has remained undisturbed ever since.

Austin and Campbell Placer Mine

(Now known as the McConnell and Quin), adjoins the Pacific ground below on the Klamath. At this point the current is divided by Gold Island, and during high water the river flows on both sides of it. Work, however, is suspended in winter at the high water stage, at which time all the mining machinery is submerged, and the sinkings or excavations are filled with detritus and debris, which have to be removed the following summer. The size of this claim is forty acres, and its altitude above sea level two thousand and fifty feet. It fronts two thousand six hundred and fifty feet on the river, has two channels back and front, the course of which are northwest and southeast. The width of gravel from rim to rim, or width of pay channel, is nine hundred to one thousand two hundred feet, the best pay being limited to forty feet in the center. The height of gravel and top soil is about fifty feet. There are heavy bowlders on the bedrock with clay and some cement; the gravel gradually decreases in size till the top strata of sand and loam are reached. The pay is somewhat irregular; but

four lakes; the small lake, three quarters of a mile below the mill, is used to hold the tailings, the higher lake, directly under the snow-capped buttes, feeds the waters of the melting snow to the reservoir which furnishes the mill with power.

Altitude	7,200 feet.
Number of stamps	40
Weight of stamp	750 pounds.
Drop of stamps	7 inches.
Drops	80 per minute.
Duty of stamps	80 tons in twenty-four hours.
Average width of vein	6 feet.
Size and character of screens	No. 7 slot.
Width of apron plate	48 inches.
Width of sluice plates	15 inches.
Water used	30 inches per day.
Pressure of water	230 feet.
Cost of mining	$2 per ton.
Cost of milling	75 cents per ton.
Percentage of recovery saved in batteries	75
Percentage of recovery saved on plates	25
Number of men in mine	60
Number of men in mill	10
Total number of men employed	125
Length of tunnels	No. 1, 1,350 feet; No. 2, 2,200 feet; No. 3, 1,650 feet.
Length of ore shoot	800 feet.

THE RAINBOW MINE.

This mine, which is located in Chipps Flat District, at an altitude of three thousand eight hundred feet above sea level, is opened by a tunnel two thousand three hundred feet long, with an upraise of four hundred and thirty-one feet, connecting with an upper tunnel and old works. Fifteen hundred feet from the mouth of the lower tunnel a turn is made, following the back ledge. Two hundred and four feet from the turn in main tunnel the pay shoot was struck, and is being followed to get under the old works, from which $300,000 was taken. The ore is found in bunches and short shoots. The sulphurets, arsenical and iron pyrites, are saved on Frue concentrators, and run from 1½ to 2½ per cent, having a value of $80 per ton. The hanging-wall is slate, and the foot-wall is serpentine. The course of the vein is southeast and northwest, dipping to the north about 60 degrees, with an average width of about three feet. Vertical depth from surface reached in lower tunnel is about seven hundred feet. Size of claim, seven thousand three hundred and sixty-five feet in length by four hundred feet wide. Water for mining and milling purposes is conducted through three hundred feet of flume, fourteen by twenty-eight inches, carrying three hundred inches of water, with a pressure of one hundred feet, which produces sufficient power, through the aid of two Pelton wheels, to run a Richmond compressor, two Ingersoll drills, and the ten-stamp mill.

Altitude	3,800 feet.
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamps	7 inches.
Drops of stamps	85 per minute.
Duty of stamps	28 tons in twenty-four hours.
Shoes and dies	White iron.
Cost of shoes and dies at mill	5 cents per pound.
Screens	No. 40, round punched.
Size of apron plate	4½ by 5 feet.
Length of sluice to each battery	12 feet.
Feeders	Hendy Challenge.
Concentrators	Frue, 4
Number of men employed when mill is running	27
Average wages paid	$3 per day.

RISING SUN MINE.

This property is situated in the Alleghany Mining District, at an altitude of four thousand seven hundred feet above the level of the sea. The course of the vein is north and south, and dipping to the west at an angle of 80 degrees, and has an average width of four feet. Dimensions of claim are two thousand five hundred feet by six hundred feet. The length of ore shoot is six hundred feet, and the ore is free milling, containing 1½ per cent of sulphurets, valued at $100 per ton. The developments consist of three tunnels following the course of the vein. No. 1 tunnel is in one hundred and twenty feet, No. 2 is in one hundred and forty feet, and No. 3 is in one hundred feet; the latter reaches a vertical depth of four hundred and seventy-five feet on the vein.

THE EAGLE MINE

Is located in the Chipps Flat Mining District, at an altitude of four thousand four hundred feet above sea level. The course of the vein is north and south, dipping to the east, with an average width of three feet, and carries 2½ per cent of sulphurets. Dimensions of the claim are one thousand five hundred feet in length by six hundred feet wide. The length of the pay shoot exposed is three hundred feet, and still in ore. The mine is opened by tunnel, following the vein three hundred feet in length, which reaches a vertical depth of one hundred feet from the surface. The hanging wall is syenite, and the foot-wall is serpentine. The company stoped three hundred tons of quartz, which milled an average of $30 per ton. This property can be worked by water power, both for milling and mining, by running a tunnel from the creek below, where at least five hundred feet of reserves can be had. The company propose putting up a ten-stamp mill at an early day.

THE MYRTLE MINE

Is located in the Downieville Mining District, at an altitude of three thousand five hundred feet above sea level. The course of the vein is northwest by southeast, dipping to the north at an angle of 60 degrees, having an average width of three feet, inclosed between a serpentine hanging-wall and a slate foot-wall. At a depth of forty feet from the surface, or from where the vein was exposed by hydraulicking, a tunnel was run at right angles to the vein, which it reached at a distance of fifty feet. A drift run north on the vein one hundred feet, exposed rich quartz and a good pay shoot all the way.

GOLD BLUFF MINE

Is located one and one half miles north from the town of Downieville, on the North Fork of the Yuba River, at an altitude of three thousand two hundred feet above the sea. Extent of claim, four thousand five hundred feet by six hundred. Course of vein north and south, with a dip to the west at an angle of 45 degrees; hanging-wall, porphyry; foot-wall, slate. Average width of vein three feet on the north ledge, and a pay shoot fifty feet in length so far as exposed, and still in ore. The west ledge averages four feet in width with a pay shoot one hundred feet in length and still in ore. The mine is worked through a tunnel two thousand feet in length, which gives a vertical depth of nine hundred and fifty feet from the surface. The west ledge was discovered by crosscutting, and has added greatly to the value of the property. The twelve-stamp mill, four stamps to battery,

is run by water delivered on an overshot wheel. This claim was located in 1851, and has been worked with but a few intermissions since that time. The ore is free milling and the result of five hundred tons crushed in the month of May, 1888, gave an average of $22 per ton.

The owners of this property contemplate increasing their plant to a forty-stamp mill in the near future. There is abundance of water for all power necessary. The ore contains from 3 to 4 per cent of sulphurets, valued at $200 per ton, saved at present by the old rocker process.

Altitude	3,200 feet.
Length of ore shoots (two)	50 and 100 feet.
Vertical depth from surface reached by tunnel	960 feet.
Cost of mining and milling	$2 50 per ton.
Number of stamps	12
Weight of stamp	650 pounds.
Drop of stamps	6 inches.
Drops of stamps	60 per minute.
Duty of stamp	1 ton in twenty-four hours.
Size of screen	Slot, No. 6.
Dimensions of apron plate	4 by 6.
Width of sluice	12 inches.
Length of sluice	36 feet.
Kind of feeder	Hand.
Shoes and dies	White iron.
Percentage of sulphurets	3 to 4.
Value of sulphurets	$200 per ton.
Number of men in mill	5
Number of men in mine	13
Total number of men	18
Average wages	$3 per day.

BUFFALO MINE.

Location, Hog Cañon District, nine miles northwest from Sierra City. Altitude, four thousand eight hundred feet above sea level. Course of vein, northeast and southwest, dipping west. It is very straight, has an average width of twenty feet, and carries about 2 per cent of sulphurets. Dimension of claim, four thousand five hundred feet by six hundred feet, consisting of three locations of one thousand five hundred feet by six hundred feet. The length of the pay shoot exposed is four hundred feet, and is still in ore. There is a shaft fifty feet in depth on the vein. The length of tunnel is four hundred feet, following on the vein. Vertical depth from surface reached in No. 2 tunnel, five hundred feet. Formation of walls: Hanging wall, porphyry; foot-wall, slate. Timber for all mining purposes is on the company's ground

The ore, which is free milling and partly honey-combed, has a value of $30 per ton. The company proposes erecting a mill the coming season, to be run by water power.

DRIFT MINES.

BALD MOUNTAIN EXTENSION CLAIM.

This property, located near Forest City, at an altitude of four thousand seven hundred feet above the sea, comprises an area of eight hundred acres, traversed by an ancient river channel, which here bears north 30 degrees east. Length of tunnel, eight thousand feet; cost, $6 per foot. The depth of gravel drifted is three feet. The pay per carload of one ton varies from $1 to $3. One man will take out about six carloads per day on the average. Sixty men are employed. Wages, $3 per day. Gross product from $6,000 to $20,000 per month. This claim has been worked to great disadvantage owing to the great length of the tunnel, supplemented by an incline of

thirty feet, through which the work of development and gravel extraction had to be carried on. On reaching the mouth of the tunnel, the gravel is washed in sluices. This company has paid dividends from February 19, 1884, to April 9, 1888. Total amount of dividends paid per share to date is $3,525, on a basis of twenty shares in the company. Total amount disbursed as dividends, $70,500.

A new tunnel is being run from the north side of the ridge, or Mammoth Springs side, which will reduce the expense of the company in mining the gravel and transporting the same to the sluices for washing fully one half of the former cost.

SOUTH FORK MINE.

This property, which consists of twenty claims of two hundred feet each, is located near Forest City, at an altitude of four thousand six hundred feet above sea level. The channel here courses southeast, and has been opened by a tunnel two thousand four hundred feet in length. An air shaft extends to the surface, a distance of one hundred and eighty feet. Cost per foot for tunnel, about $6. The pay gravel drifted is about four feet deep; value from $1 to $5 per carload, about five carloads per day per man being taken out. The width of the channel is about six hundred feet from rim to rim. At present the company has six men, at $3 per day each, running the main tunnel ahead.

ECONOMIC MINERALS.

Besides gold-bearing quartz veins, drift diggings, and other forms of auriferous deposits, Sierra contains silver, copper, and iron ores, the latter occurring at Gold Valley in quantities and of very superior quality, the conditions here being at the same time extremely favorable for large and cheap production. The only obstacle to the manufacture of iron at this point on an extended scale is the cost of transportation to market, the locality being in the mountains and a long distance from any railroad. While this iron ore, of which thousands of tons are in sight, has been tested and its excellence fully established, not enough has been done with the silver and copper deposits found in this county to determine either their extent or value.

CAMPBELL HOT SPRINGS.

These springs, three in number, are situated one mile from the town of Sierraville, at an altitude of five thousand and twenty-five feet above the level of the sea. One of these springs is cold, the other two have a temperature of 104 degrees Fahrenheit. They occur in a volcanic district, and the waters, which are sulphureted, are said to be efficacious in the treatment of kidney diseases, rheumatism, etc. Visitors are numerous here during the summer, there being a good hotel at the place with facilities for bathing.

SISKIYOU COUNTY.

Siskiyou County lies between the parallels 41 and 42 degrees north latitude, and 121 and 124 degrees west longitude. It is the central of the three most northerly counties of the State, bounded on the east by Modoc County, on the south by Humboldt, Trinity, and Shasta Counties, on the west by Humboldt and Del Norte Counties, and on the north by the State of Oregon.

Pine Grove Placer Claim.

This claim lies between the Barkhouse and the McKinney Creeks, on the south bank of the Klamath. The claim consists of sixty acres of patented ground, including not only the river channel, but the high bars or bank claim. It is now leased to Chinamen, who pay a royalty of 25 per cent on the gross proceeds.

Buckeye Bar Placer Mining Company

Is the next claim below, at the mouth of the McKinney Creek, consisting of forty acres, with two thousand two hundred and fifty feet of channel frontage. It is situated on a high bar, forty feet above the present river bed, and is worked with man power by fourteen Chinamen. The claim is nearly exhausted.

McKinney Creek is about five miles long, and has been worked over more or less for the entire distance. It still pays when water can be obtained in the winter.

SOUTH SIDE OF THE KLAMATH.

On this side of the river there are several claims that have but little value, and are only worked occasionally, and then in an uncertain way.

Oak Bar

Is a small town, with Post Office, supply store, and hotel. This bar has been a generous producer, but is now nearly cleaned up. It is evident that an older and richer channel, at present covered with debris, carried the values, instead of the present one. This is proved by the working of the

Kohl Placer Claim,

Situated on a high bar north of this claim, now owned and handled by thirteen Chinamen.

The Poverty Point Placer Claim.

This is the only claim that has entered the back channel, and proved its richness. It has, however, been worked in a desultory way, and without much system, owing to the want of experience in drift mining by those employed. This claim was located in 1880, and is about half a mile from Oak Bar, the nearest town. The area is fifty-eight acres, and the course of the lead is easterly and westerly. The rim and bedrock are syenite, and the width of the pay channel one hundred and fifty feet. Gravel has been drifted to a height of four feet; its character pebbly, with a few big bowlders, some clay, and a little cement, and is washed in sluices. There are three tunnels—No. 1, three hundred feet in length, with crosscut of one hundred and fifty feet, runs through rim rock into the channel; No. 2, same as No. 1; No. 3 is two hundred and fifty feet in length, with a crosscut in the river. The cost of running these tunnels in the bedrock was $10 per foot; in gravel, $1 50. Fir was used in timbering, at a cost of 5 cents per running foot. It was hauled to the mine a distance of two miles. The capacity of each car is three fourths of a ton, and pay $2 52 per load. Each man (three to five being employed) is expected to take out four carloads per day, at a daily wage of $2 50 for ten hours. There is no night work done here. No. 1 tunnel has a breast eight hundred feet long; No. 2, two hundred and twenty-five feet long and thirty to sixty feet wide; No. 3 is

yet in rim rock. There are but few bowlders, and but little water in the workings. The claim has been worked in an irregular way for eight years, and during this time the gross production amounted to $20,666 33. The company owns a ditch two thousand two hundred and fifty feet long, which takes water from the Klamath River.

The Sambo Bar Claim

Is opposite the Poverty Point on the north side. It contains thirty acres and is leased to a Chinese company of eighteen. It was found in full operation, with complete outfit. The gravel was reported rich, but no detailed information was obtainable.

The John China Placer Mining Company

Is the adjoining claim below. It measures thirty acres. Four hundred feet by one hundred and fifty in width of the river bed have been reclaimed for mining purposes by the wing dam system. This claim is worked by sixteen Chinamen, day and night, and is reported to have paid richly last year. Several of the owners have returned to China on the results of their individual profits.

Proceeding in a southerly direction, the banks of the Klamath were strewn with broken wheels, pumps, and other machinery—outfits rescued from the previous season's rush of waters.

HORSE CREEK.

From the last named point, down the river, the course of which is south 20 degrees west, a bench fifty feet above the river bed, carrying gravel, one hundred and fifty feet in height, may be seen. This gravel is reported rich, but is not worked, as the owners are too poor to pay for bringing water on the claim.

The China Sam Placer Company.

The property of this company is thirty acres in extent and is worked by fourteen Chinamen by the wing dam system in the bed of the river.

The Hongkong China Wing Dam Company.

This claim is on the same side of the river as the above, and adjoining. The working force consists of fourteen Chinamen.

The Canton Placer Mining Company.

This property, with an area of forty acres, is worked by a company of eighteen Chinamen day and night. It lies two miles from the Hongkong. The "pit" is down to bedrock, and the wash-gravel reported rich.

SCOTT RIVER TO ORLEANS BAR.

Descending the Klamath, a change in the character of the alluvium occurs, which necessitates a different method of treatment to extract the gold. Surface ground and shallow diggings required the pick, shovel, and sluice; then the wing dam system in the river beds followed, and when the pay lead diverged from the river bed it was prospected for and found in what is known as the back channel, on about the same, or even a higher, level, and then drifting, or what is known as "drift diggings," were instituted.

Reaching the junction of the Scott River with the Klamath, it is found that still another and more important change has taken place. Here are terraces, or benches, usually three in number, with well defined, trough-shaped depressions, rims intact, receding and ascending gradually from the river bed or its banks, and forming a series of steps, from two hundred to three hundred feet apart, and from fifty to two hundred feet between the respective channels. These are evidently the old river courses, buried in places a hundred feet deep under the rocky debris that had slid from the mountain side during a cataclysm or a convulsion of nature, causing new channels, cutting deeper into the rocky formation, to be formed. In order to work this kind of deposit either the drift or the hydraulic method had to be resorted to. The latter has been adopted as the only means possible under the circumstances.

From the mouth of Scott River the distance (including contour lines) to Orleans Bar is seventy-eight miles. The Klamath enters Humboldt County near this point. Here, with the Salmon River (a tributary to the Klamath, and the length of which from mouth to source is fifty miles exclusive of its tributaries) we find not less than one hundred and twenty-eight miles of this kind of mining ground, on which there are a large number of claims worked by the hydraulic system, and most of them in operation.

HAMBURG BAR.

Passing the mouth of Scott River, an important tributary to the Klamath, with many claims (described elsewhere) located there, Hamburg Bar is reached in a distance of two miles. Here, drifting in the back channel under the bar is the method of mining pursued.

Tibbet & Co.'s Placer Claim

Has one hundred feet frontage extending back to the rising rock, and employs four men.

Mapleson & Co.,

With a frontage of six hundred feet, work seven men.

Singleton & Co.

Drift from a vertical shaft forty feet deep, with four hundred feet of lateral drifts in the center of the back channel. A river wheel furnishes power. In winter work is suspended on the river, and the time is occupied in washing a bank claim. These mines are reported to be making good returns.

SEIAD VALLEY MINING DISTRICT.

On the south side of the Klamath River, nine miles and a half from the above point, is located, in Seiad Valley Mining District,

THE GRIDER HYDRAULIC PLACER MINE.

It is one hundred and thirty-three acres in extent, sixty of which are held under United States patent. The nearest town is Hamburg, at a distance of nine miles and a half in a southeasterly direction. The height of the claim above sea level is one thousand five hundred feet. From rim to rim rock the width of gravel, or of the pay channel, is not definitely known, but the general width is estimated at two hundred feet. The course

is northwest and southeast. The thickness of gravel up from bedrock is twenty feet, and its character is that of river wash, but carrying heavy bowlders. Frontage of the claim on the river is five hundred feet. There are two benches, the first twenty feet high, and the second one hundred and fifty feet. From the first of these the height of the bank is eighty feet. One acre and a half of gravel is moved during a season. The height of dump above the river bed is ten feet. Six hundred feet of sluices are used, with wooden block riffles. The grade of the sluices is six inches to the box of sixteen feet, and their dimensions thirty by sixteen inches. Water is supplied from Grider Creek by a ditch two miles in length, having a grade of one inch and a half to the rod. The pressure of water at the benches is one hundred and forty feet, and the quantity used is nine hundred miner's inches. The water is the property of the owners of the claim. From six hundred to seven hundred pounds of Giant powder are consumed during the season, and one flask of quicksilver is in use, the loss on which in that time is about 40 per cent. This claim is worked both night and day, coal oil being used to light the scene of operations, at a cost of $1 50 per night. Two Giants, Nos. 1 and 2, are in use, with nozzles three and a half and four and a half-inch, respectively, and one thousand four hundred feet of pipe, fifteen and eleven-inch. Fourteen men, receiving $2 50 per day each, are employed, divided into day and night shifts of seven each, and working under a foreman. The product of the claim for the season of 1877 was $15,600.

On the north side of the Klamath River is found

THE LONDON PLACER MINING COMPANY,

With one hundred acres of ground, situated forty feet above the river bed, and worked by the hydraulic method. Water is brought from Walker Creek in a ditch one mile and a half long, carrying six hundred inches, miner's measurement. The water is delivered at the claim under a pressure head of three hundred feet. The bank worked is twenty feet high. Day and night shifts, six hands each, are employed at the usual wages ($2 50) paid white men.

CHINA WONG PLACER MINING COMPANY

Adjoins the above. The claim is fifty acres in extent, with thirty-foot bank. Water (twelve hundred inches) is brought in a ditch from Seiad Creek, distant two miles, and delivered at the claim with a pressure head of one hundred and twenty-five feet. Twenty Chinamen are employed in day and night shifts, receiving $1 25 per day.

THE PORTUGUESE FLAT HYDRAULIC MINING COMPANY

Is in operation one mile from the China Wong. It is situated near the mouth of Portuguese Creek, Sec. 4, T. 46 N., R. 12 W., and consists of one hundred acres of placer ground, with one mile frontage on the Klamath River. The gravel banks of this claim are different in character from any other found on the river, excepting those in the pliocene channel at Rancheria Gulch. They carry considerable cement, and powder could be used to advantage. The claim is in Seiad Flat Mining District, and the nearest town is Hamburg Bar, eleven miles distant in a southeasterly direction. It is one hundred acres in extent, with a frontage on the river of one mile, and two benches—No. 1, elevated fifty feet, and No. 2, one hun-

dred and fifty feet above the bed. The width of gravel from rim to rim and the width of pay channel could not be ascertained. The character of the gravel is pebbly, cemented in places, and carrying a stratum of pipe-clay; lower stratum blue, with few bowlders. A strip of pay gravel, ten feet square from bedrock to surface, paid $10 per day to the man. The height of the banks is eighty feet; thickness of gravel from bedrock (talcose slate) up, eighty feet.

The claim has been worked for one year, but so irregularly that the quantity of gravel moved per month, or for the season, could not be ascertained. Length of sluices, five hundred and forty feet, thirty by sixteen inches in size; grade, five and one half inches to the box of twelve feet long; riffles used, wooden blocks; height of dump above river bed, ten feet. A ditch one mile and a half in length, owned by the claim proprietors, conducts water from Portuguese Creek. The size of the ditch is four by three feet, and the grade four inches to the rod. The pressure head of water at the benches is three hundred and twenty-five feet, and the quantity used, in miner's inches, is two thousand. For six months there is a full supply of water. For the remainder of the year the flow is smaller. The claim is worked night and day, and is illuminated by a headlight coal oil lamp, at a cost of $1 50 per night. There are two Giants in use, Nos. 1 and 2, with nozzles respectively four and one half and three and one half inches. A third Giant is about to be brought into service. The pipe (fourteen and ten-inch diameter) is five hundred feet in length. A day and night shift of six men each are employed, the white men receiving $2 50 and Chinamen $1 25 per day.

ON THE EASTERLY BANK OF THE KLAMATH.

At a point one mile from the last mentioned claim the river, changing from a northwesterly course, takes a sharp turn southerly. Passing Baileys, after four miles' travel on the opposite side, or easterly bank of the river,

Fort Goff Hydraulic Placer Claim

Is reached. This ground has a frontage on the river channel of one thousand two hundred feet, and an area of one hundred and twenty acres. One of its marked features is the blood-red color of the soil, gravel, and hillside. It has been worked since 1854, first as a sluice, and then as a drift claim, and with much success during the past eight years by the hydraulic method. The mining district is the Seiad, and the nearest town Happy Camp, lying southwesterly, at a distance of thirteen miles. This claim has three benches, elevated, the first, twenty-five; second, seventy-five; and the third, two hundred feet above the river bed. The height of the banks is sixty feet. Thickness of the gravel, up from the bedrock, which is a metamorphic slate, forty feet. The course of the lead or channel is southerly. The width of gravel, from rim to rim, and width of pay channel have not been determined. The character of the gravel is heavy river wash, with large and small bowlders. There are four hundred and eighty feet of sluices, thirty by forty inches, in use, and graded six inches to twelve feet. The riffles are wooden blocks. Height of dump above the river bed, eight to ten feet. Water is supplied by two ditches, the first three miles long, the second one mile and a half, with three feet bottom and four and one half feet top, by thirty-six inches deep. The grade is one inch to the rod. Capacity of ditch and flume is two thousand inches. The quantity of water used is one thousand two hundred miner's inches; pressure at the

benches, two hundred and eighty feet. The water (property of the claim owners) is taken from Goff Creek. The claim is only worked seven hours per day with one No. 2 Giant, nozzles three and one half and four and one half inches, and one thousand two hundred feet of pipe. Seven men are employed at the usual rate of wages, $2 50 for white hands, and $1 25 for Chinamen.

The Shirer Placer Claim.

This property lies to the south of the "Fort Goff." Hydraulic work is being done on the second bench of this claim, the water being taken from Shirer Creek by means of a three-foot ditch, one mile and a quarter long. The claim, for the most part, is as yet virgin ground, and is said to be paying well.

The Reeves Hydraulic Placer Claim

Is a property of some note, on the east side of the Klamath. It contains one hundred acres held under United States patent, and has been worked closely and regularly for the past thirty years. Originally it was operated simply in the sluicing way, but for fifteen years the more extensive and efficient hydraulic system has been in use. This claim is said to have been one of the best on the river, and is now paying. It lies six miles west from Happy Camp, in the Seiad Valley Mining District, and shows three benches at an elevation of from twenty-five to three hundred feet. The second bench, fifty feet above the river bed, is now being worked.

Thickness of gravel (slate), from bedrock to surface, is forty feet. The character of the pay gravel is pebbly, small, light, and easily washed, with but little clay cement and few bowlders. The sluices, in which are wooden block riffles, are nine hundred and sixty feet long; the size, thirty by sixteen inches; the grade, six inches to the box of twelve feet. The height of the dump above the river bed is twenty feet. Water is brought from China Creek in a ditch one mile and a half long, three feet wide at bottom, four and one half feet at top, and two and one half feet deep; the grade is two and one half inches to the rod. Through this ditch one thousand five hundred miner's inches of water (owned by the claim proprietor) are delivered at the workings, the pressure head at the benches being three hundred feet. The supply is ample all the year round. The claim is now worked day and night, coal oil, at a cost of $1 50 per night, being used for lighting. Two Giants, with nozzles three and one half and four and one half inches, respectively, and connected with one thousand two hundred feet of pipe, are in use. Five boxes of Giant powder are consumed, and one flask of quicksilver is in use (the loss being 40 per cent) for a season's work, the length being twelve months. Six men are employed in the day, and the same number at night. Wages, white hands, $2 50; Chinamen, $1 25.

The Gordon Placer Mining Claim.

This claim is situated at the head of Muck-a-Muck Flat. It contains one hundred and fifty acres, and controls the background of a two thousand two hundred and fifty feet frontage on the river channel, with its three benches or terraces. The bench now being operated carries from forty to seventy feet of a bank with from twenty to thirty feet of gravel. Water is taken from Horse Creek, distant one mile and a half, in a three-foot flume. The season is short, only lasting through the winter or rainy months. Pay gravel is reported good.

Muck-a-Muck Placer Claim.

From the Gordon, westerly, following the river in its tortuous windings, the above claim is reached at a distance of five miles southwesterly from the town of Happy Camp. It lies fifty feet above the river bed, is located at the head of Muck-a-Muck Flat, and has an area of one hundred and fifty acres. It is two thousand six hundred feet wide, with a frontage of five thousand two hundred feet on the river. This claim has been worked entirely by sluicing for the past twenty years, as water is too scarce to hydraulic. The season lasts from three to five months, and during that time some eight or ten hands, principally Chinese, are employed. There are two terraces, or benches, on the claim, but only one, fifty feet above the river bed, has been worked. This bench contains twenty feet of gravel and earth. Water is brought on the claim from Ambrose Creek, four miles distant, through a two-foot flume, with a five eighths-inch grade to the rod. The ditch carries four hundred inches, miner's measurement. The gravel of the Muck-a-Muck is washed through thirty sluices, each twelve feet long, with a grade of six inches to the box of twelve feet.

The Del Norte Mining Company's Claim

Is reached in a distance of three miles, traveling north 10 degrees west from the last mentioned property. It is under the control of an agent, representing the owners, who reside in San Francisco. The property has been leased for many years by a company of Chinamen, and during all this time has produced more largely than any placer claim in the county. According to the most reliable information obtainable, the output for the last twenty years approximates $1,000,000. The larger portion of this amount found its way to China without being handled by any one but the lessees.

In location the Del Norte claim bears north 30 degrees east from the town of Happy Camp, from which it is two miles distant. The river at this point forms a horseshoe shape in its course, the claim being situated at the "toe," or upper part, and in a slight depression. It covers the area known as Elk and Woods Bars, and contains one hundred and ninety-five acres, covered by a United States patent. Fifty acres of the ground have been exhausted, and about one hundred and forty-five remain virgin. In this area there are three terraces or benches of back channel; the bench worked at the present time is the upper one, three hundred feet above the river bed; the elevations of the two others are respectively fifty and two hundred feet. The altitude of the claim is one thousand three hundred feet above the sea level. The height of the banks, at the time of our visit, was thirty feet. The bedrock is slate, and the thickness of the gravel from that up to the surface is twenty feet. Character of the pay gravel is river wash, rather heavy, and with quite a number of large bowlders; the pay, per season, is said to be $50,000, approximately $20,000 to the acre. Length of sluices, two thousand four hundred feet; grade, from four to seven inches to the box of twelve feet; size, three feet by twenty-four inches. Wooden blocks and flat iron bars are used as riffles. Two and a half acres of gravel are moved during a season. The Del Norte's ditch is eleven miles long. The water flowing in it comes from Elk Creek, the quantity used at mine being three thousand inches; at the benches the pressure head is one hundred and fifty feet. This claim, as is usual with the Chinese, is worked both day and night. It is lighted with coal oil at an expense of $2 per night. Three No. 2 Giants, with four, four and a half, and six-inch nozzles and one thousand five hundred feet of fifteen-inch

pipe, are used in hydraulicking. Twelve men are employed on the day shift, and thirteen at night. The wages are from $1 to $1 25 per day. This claim has been worked for twenty years.

HAPPY CAMP.

Leaving Del Norte claim, and following the river on the west bank, the village of Happy Camp is reached, the distributing point for the Seiad Valley Mining District, and the country generally between Hamburg Bar, thirty-three miles distant, and Orleans Bar, sixty-three miles. Happy Camp contains several heavily stocked general merchandise stores, a Post Office, a Wells-Fargo agency, hotels, etc. It is situated at the confluence of Klamath River and Indian Creek, the latter an important tributary to the former, fifty feet above the river bed, and one thousand three hundred and fifty feet above the level of the ocean. The village has on all sides an ample expanse of mineral land, more or less exhausted of its auriferous stores, particularly where the layer of gravel was shallow and easily removed. These spots, it is chronicled, yielded large returns for the labor expended. That portion of the deeper gravel banks requiring capital to furnish mechanical means for removal, was segregated and sold to a New York syndicate. The output of this ground, according to estimate, has been in the aggregate, $500,000.

Happy Camp Placer Mining Company.

This consolidated company is known by the above name. The company's property embraces five hundred and seven acres of mineral land, with three benches or terraces of varying elevations, filled with alluvial deposits. Water being abundant, the ground is worked without cessation the year round. The company have in use two No. 2 Giants, with from fifty to two hundred sluice boxes of twelve feet each in length, set at a three-inch grade to the box. From ten to twelve men, principally Chinese, are employed and paid $1 75 per day each. Water is taken from Grider Creek and the South Fork of Indian Creek. The Grider ditch is three miles long, carrying one thousand two hundred inches of water; that running from Indian Creek is eighteen miles in length—it has a capacity of three thousand inches, miner's measurement.

INDIAN CREEK.

Indian Creek is tributary to the Klamath River, intersecting it at Happy Camp, and extends due north sixteen miles. Its tributaries, east and west, embrace fourteen miles, and its watershed is an area of one hundred and forty-four square miles. The source of the creek is in the lofty snow-clad peaks of the Siskiyou Mountain Range. The snows of Mount Preston and other elevated points feed it with a never-failing supply.

CLASSIC HILL GOLD MINING COMPANY.

At a distance of sixteen miles northerly from the mouth of this creek, and at an altitude of two thousand five hundred feet above the level of the sea, the claim of this company is reached. It is in the Happy Camp Mining District, and consists of sixty acres, thirty of which are covered by a United States patent. The formation is a soft talcose slate, intercalated with stringers of quartz, which in places concentrate and form a well defined

four-foot quartz vein, rich in free gold. This kind of deposit is known as "seam diggings" in Placer and El Dorado Counties. The Classic claim is owned and operated by the Chinese firm, How & Company representing the See Yup—one of the six influential Chinese companies, whose headquarters are at San Francisco. The actual output of the claim could not be ascertained. Report, however, credits it with being the second richest as a gold yielder in the county. It has been worked for the past twenty years, and is now operated by the hydraulic plan. There are one hundred and fifty feet of backs in the face of the cut as it enters a high hill. The outfit consists of a No. 2 Giant, with one thousand five hundred feet of twelve and fourteen-inch pipe, and four and four and a half-inch nozzles; seventy sluice boxes, twelve feet each in length, with thirty-inch bottom and twenty-four-inch side, with wooden blocks for riffles, and a grade nine inches to the box. The claim is worked both day and night by nineteen men. At night the claim is lighted by pitch pine at a cost of $1 25.

Adjoining the Chinamen's ground, a single individual is working a claim in the same formation, with good results. He ground sluices whenever he can obtain water.

THE DAVID HUGHES PLACER CLAIM.

One mile and a half from the last named point, the same formation continuing, is the Hughes claim, consisting of forty-five acres. The owner works by hydraulicking for three or four months in the year, or whenever water is in supply. This claim was located ten years ago, and has since been regularly worked during the winter and spring months.

THE GRIDER HYDE PLACER CLAIM.

Leaving Happy Camp Village, and the Happy Camp Mining Company's ground, on its southwesterly boundary, the claim named is reached, still in the limits of Happy Camp Valley. Its area is one hundred and sixty acres, held by a United States patent, and the ground is worked by the Chinese firm of Ock & Co., under a lease. Work is pushed vigorously day and night by a force of twenty men equally divided into shifts.

THE OCK & COMPANY PLACER CLAIM NUMBER 2.

Two miles distant on the west side of the river, Ock & Company have leased another claim under the above name. The property consists of sixty acres of ground, held by white owners under United States patent. It has been regularly worked for the past thirty years, for the most of the time as a drift and sluicing claim. The hydraulic plan has only been introduced lately. Happy Camp is the nearest village, being distant one mile in a southwesterly direction. The thickness of the gravel from the bedrock, which is talcose slate, up to the surface is from fifteen to twenty feet, its character, ordinary river wash with heavy bowlders, requiring a good deal of blasting. There are two terraces, or benches, at an elevation above the river bed of from fifty to one hundred and fifty feet. Height of banks, fifty feet. The sluices are five hundred feet long; size, twenty by sixteen; grade, nine inches to the twelve-foot box. The riffles used are wooden blocks. Water, taken from Grider Creek, and owned by the proprietors of the claim, is supplied by two miles of ditch, four feet wide, with a grade of half an inch to the rod. Its capacity is one thousand inches. The quantity of water used is eight hundred inches under a four-inch pressure head; the pressure head at the benches is two hundred

feet. Eighteen men, divided into two shifts of nine each, work the claim night and day. The workings are lighted after dark with pitch pine at a cost of $1 25 per night. Two No. 2 Giants are in play with four and a half-inch nozzles and one thousand nine hundred feet of eleven and fifteen-inch pipe. Five to ten boxes of Giant powder are consumed each season, and one flask of quicksilver is used at a loss of 40 per cent. The claim has been worked thirty years. The length of the season is from eight to nine months.

WINGATE HILL PLACER CLAIM.

This property is situated at a point seven miles southwesterly from Happy Camp, and is worked on the hydraulic plan, the water being taken from Wingate Creek. This claim formerly yielded richly, but at present writing is nearly exhausted, and is being worked back on the second terrace to a point nearly under the ditch. It is operated by four men, who use one hundred and fifty feet pressure head of water.

THE HALEY AND HALSTEAD CONSOLIDATED PLACER MINING COMPANY.

The company controls a group of three claims: The Last Venture, seventy-seven and sixty-nine one hundredths acres; the Haley, thirty-nine and fifty-one one hundredths acres; and the Halstead, twenty acres; in the aggregate, one hundred and thirty-seven and thirty one hundredths acres; having a frontage on the river of two miles, and controlling an unlimited supply of water from Clear Creek, with any desired amount of pressure. This creek has its source in the Siskiyou Range of mountains, twenty miles distant, and is fed by a broad watershed. The Last Venture has been worked but one season, and is not yet fairly opened. It has three terraces, or benches, with the following elevations above the river bed: No. 1, the lowest, four hundred and fifty feet; No. 2, six hundred and fifty feet; No. 3, eight hundred and fifty feet. The gravel bank of No. 3, where work is now going on, is one hundred feet in height, and its nature pebbly, with but few bowlders. The bedrock is slate. The Haley has two terraces, or benches, of the old river channel, and is being developed by a limited working force. The Halstead is lying idle for the present.

Happy Camp is the nearest place to this company's claims, being about eight miles distant, in a direction south 20 degrees west. The working of the Haley is detailed as follows: The Haley ground is at present handled by five men, receiving an average wage of $2 50 per day. The two terraces, or benches, are at an elevation above the river bed of two hundred and five hundred feet, respectively. The width of gravel from rim to rim is not yet determined, nor is the width of the pay channel, the course of which is southerly. In character, the pay gravel is pebbly, with but few large bowlders, requiring no powder to blast nor derricks to move them out of the way. Being in process of development, the pay of the gravel per cubic yard is as yet undetermined; thickness of the gravel from bedrock up, twenty feet; height of banks, thirty feet at time of visit, but gradually increasing. Length of sluices, two hundred and forty feet; size, twenty by twenty inches; grade, seven inches to the box of twelve feet; wooden block riffles are used. Height of dump above river bed, one hundred and fifty feet. The ditch is three miles long, and the water is taken, as before mentioned, from Clear Creek, the right being vested in the owners of the claim. Size of the ditch is three and one half feet, with a grade of three fourths of an inch to the rod, and has a carrying capacity of four hundred and fifty miner's inches, with a pressure at the benches of four hundred

feet. The supply of water is unlimited. One No. 2 Giant is in use, with two and one half and four-inch nozzles, and one thousand feet of eleven, fifteen, and sixteen-inch pipe. One box of Giant powder is consumed, and one flask of quicksilver is in use during the season; a loss of 40 per cent was sustained on the latter. The claim has been worked one season of ten months.

THE BUNKER HILL PLACER CLAIM

Is located about two miles below the Consolidated, on the east side of the river. It was first worked on the hydraulic plan in 1873, and has so continued up to date, with (according to report) profitable results. In its equipment the Bunker Hill is considered the model claim of the county. In area the claim is two hundred acres, one half of which is exhausted. It is in the Happy Camp Mining District, and the town of that name is the nearest, being about ten miles distant in a southerly direction. The river frontage is very nearly two miles. There are three benches, rising above the river bed at the following elevations: No. 1, fifty feet; No. 2, two hundred and fifty feet; No. 3, eight hundred feet. Width of gravel from rim to rim, one thousand three hundred feet; course of lead or channel, north 20 degrees east; height of the banks, twenty to one hundred and fifty feet; thickness of gravel from bedrock (slate) to surface, an average of thirty feet. Its character is pebbly, with some cement and coarse gravel, and a little pipe clay. The sluices are three hundred and sixty to eight hundred and forty feet in length (depending on position); size, twenty-four by twenty inches; grade, eight inches to the box of twelve feet. Wooden block and iron bar riffles are used. Of the percentage of gold recovered 80 per cent is saved in the sluices and 20 per cent in the under-currents. The height of the dump above the river bed varies from fifty to several hundred feet; it is one hundred feet at present on No. 2 bench. Five miles of four-foot ditch and flume (capacity, two thousand inches) convey water from Independence Creek, which latter is fed from Marble Mountain Lake. This body of water is about one mile in extent, and in places very deep. It is tapped at a depth of fifteen feet, and is distant from the claim ten miles. The quantity of water used is one thousand five hundred miner's inches. At the benches the pressure head is three hundred feet. The maximum supply for ten months in the year is from five thousand to six thousand inches. Five boxes of Giant powder are consumed during a season of ten months, and two flasks of quicksilver are in use, losing of the latter 20 to 25 per cent. The claim is worked day and night. Coal oil illuminates it at a cost of $1 50 per night. Two No. 2 Giants are in use, with four and five-inch nozzles, and three thousand feet of eleven, fifteen, and sixteen-inch pipe. Fourteen men are employed, exclusive of cook and foreman, divided into day and night shifts. The foreman receives $100 per month; white hands, $2 50 per day; and Chinamen, $1 50 without board. The claim has been worked for fifteen years.

COTTAGE GROVE MINING DISTRICT.

From Bunker Hill to this place, on the contour line of the Klamath River, is a distance of ten miles, and the way lies through cañons and rapids. The terraces, benches, or high bars, the scene of hydraulic operations, show no evidence of their existence until we reach the

AUBERY HYDRAULIC PLACER CLAIM,

On the west side of the river. This is a claim of twenty acres, and is situated on a bench fifty feet above the river bed, now opened and worked by the hydraulic method. The bank is twenty feet high, with thirty feet of gravel, and is worked by a No. 2 Giant, using three and four-inch nozzles. The water is taken from Aubery Creek, and is conducted by a flume one mile long, with a pressure head of two hundred feet. The sluices are six hundred feet long and in size ten by sixteen inches. The creek is limited in size, and, therefore, the mining season only lasts during the rainy months, while water is in ample supply.

ELLIOT PLACER CLAIM.

This, the next adjoining claim, is located on the west side of the river, fifty feet above its bed, with the evidences of two, if not three, terraces. The altitude above sea level is one thousand and sixty-five feet. The claim is in the Cottage Grove Mining District, the most convenient town being Orleans Bar, south twenty-seven miles, in Humboldt County. The extent of the ground is forty acres. Thickness of gravel from bedrock (slate) up to surface, twenty feet. In character it is coarse, with some large bowlders. Course of lead or channel, north and south. Length of sluices, two hundred feet; size of, twenty by twenty inches; grade of, ten inches to twelve feet. Wooden blocks are used for riffles. Height of the dump above the river bed is thirty feet. The ditch, carrying five hundred inches of water, is two miles long, and the size at bottom is thirty inches; the grade is one inch to twelve feet. The quantity of water used is three hundred and fifty inches, and is taken from Elliot Creek. This claim has also a reservoir, built of square timber, with a strong gate of planking, eight feet wide, even with the height of the dam gate, and swinging on heavy iron bolts. The gate is automatic in its action; when the reservoir fills, it yields by the pressure of the water, which escapes in a body. One No. 2 Giant is used on this claim, with three and one half and four-inch nozzles, and connected with seven hundred feet of eleven, fourteen, and sixteen-inch pipe. Two to three boxes of Giant powder are consumed during the season; also one flask of quicksilver is used, one half of which is lost. The length of the season is about four months.

HEALD'S HYDRAULIC PLACER CLAIM.

This claim is located five and one half miles due south from the Elliot, on the west side of the river, in the same district; contains one hundred and sixty acres, with a long frontage on the river, and three terraces or benches of the old channel. The second bench, which is three hundred feet above the present river bed, with one hundred feet of dumping ground, is now being developed. The bank is eighty feet high, with twenty-five feet of gravel, consisting of a light, pebbly wash with few large bowlders. One Giant is used in working the claim, with one thousand feet of pipe attached. There are three hundred feet of sluices, two undercurrents, and an unlimited supply of water from Rock Creek and other sources. Work is continuous the year through. A large sawmill is now being constructed, and ditches and flumes are being prepared, with a view to future extensive operations. At present the claim is leased to and worked by a company of ten Chinamen.

THE STENSHAW HYDRAULIC CLAIM.

This claim lies two miles distant from the last named, is situated on the east side of the Klamath, and is considered extensive as well as valuable property. The Stenshaw shows the usual number of terraces, and is worked by water taken from the Stenshaw Creek, a small stream lacking both volume and head pressure.

HALBERSON HYDRAULIC PLACER CLAIM, WEST.

This is reached by following the course of the river south 10 degrees south of west for two miles. It is situated on the west bank of the Klamath, at Horseshoe Bend, and measures fifty acres.

THE HALBERSON HYDRAULIC PLACER CLAIM, EAST,

Measures one hundred acres, and is located on the east bank of the river. Both the above claims are on the old river channels that bisect the loop, or horseshoe bend of the Klamath. The claim on the east bank has two benches, the first rising fifty feet above the river bed, with a fifty-foot bank and twenty-foot dump; the second one hundred and twenty feet, with one hundred and twenty-foot bank and one hundred-foot dump, of which forty feet are gravel. Water for this claim is taken from the Irvine Creek by a ditch, one mile and a half long. There is a reservoir here sufficiently large to store a water supply for the entire year. Without this precaution the working season would last only seven months. Developing work is now being done on the claim.

The altitude of the claim, on the west bank, above sea level, is eight hundred and twenty-five feet, and the nearest town is Orleans Bar, which lies distant twelve and a half miles in a southwesterly direction. There are three benches on the claim, respectively fifty, one hundred and twenty, and four hundred feet above the river bed. On the first bench the width of gravel from rim to rim is four hundred feet; the width on the second and third benches has not yet been determined. The character of the gravel is coarse, with some cement and clay, mixed with very heavy masses of angularly-shaped rock, the result of a hill slide. From the bedrock (slate) up to the surface, the thickness of the gravel is, on the first bench, thirty feet; on the second, fifty feet. Height of the banks on the first bench, fifty feet; on the second, one hundred and twenty feet. Length of sluices, one thousand two hundred feet; size, twenty by twenty-four inches; grade, eight inches to the twelve-foot box. Wooden blocks and iron bars are used for riffles, and in the sluices 85 per cent of the recovery is saved; in the undercurrent, 15 per cent. Height of dump above river bed is from twenty-five to two hundred feet. Water is supplied by a flume one mile in length from Haywood Creek, and is owned by the proprietor of the claim. The size of this flume is thirty by thirty-six inches, with a grade of two inches to fourteen feet; its capacity is two thousand miner's inches, and this entire quantity is used on the workings. The pressure head at benches is one hundred and sixty feet. There is a reservoir on this claim three hundred and sixty feet in diameter by seven deep. The work goes on day and night by five-men shifts, using coal oil for light at $1 50 per night. Two Giants, Nos. 1 and 2, are in use, with two and four and one half-inch nozzles, and connected with one thousand four hundred feet of eleven and eight and a half-inch pipe, of iron. In all thirteen men are employed at an average pay of $2 50 per day each.

TENEYCKE & COMPANY'S PLACER CLAIM.

This is reached by following the course of the river due south six and a half miles. This claim was located in 1874, and has been worked with a small force since that time, yielding a meager profit. The bench or channel (No. 1) now being worked has been difficult to handle on account of the gravel deposit being overlaid by the debris of a heavy mountain slide.

As the gulches and creeks from which this claim derives its water are limited in their flow, the season is necessarily short. A site has been selected for a reservoir, ten feet deep by four hundred feet long. This, when completed, will, in addition to the present supply, insure water all the year through. There is also a sawmill, cutting one thousand feet of lumber per day, attached to this property. The nearest town to the claim is Orleans Bar, in a south 20 degrees west direction, eight miles and a half away. This ground has four miles of a frontage on the river and runs back to the divide. There are here three terraces, or benches, the elevation of the first above the river bed being fifty feet, of the second two hundred, and of the third four hundred feet. The course of the channel is due south. The character of the bedrock is slate, and from this up to the surface there are twenty feet of gravel, clay, and large rocks, angular in shape, that have slid from the mountain side. A clean-up is made every month, and the pay per square foot from bedrock to surface is about one dollar. The sluices are two hundred feet in length; in size, twenty-four by twenty-six inches, and in grade, eight inches to the box of twelve feet. Wooden blocks, six inches in diameter, are used for riffles.

Water is supplied by flumes five hundred feet long and a ditch three quarters of a mile in length. The size of flume is three feet deep by twenty inches wide, with a grade of six inches to the rod. The carrying capacity of ditch and flume is one thousand five hundred inches of water, miner's measurement. The water pressure head at the benches is one hundred and fifty feet. The water is the right of the mine owners, and is taken from Teneycke and Pockey Creeks. A No. 2 Giant, with two and four-inch nozzles, and one thousand feet of ten-inch pipe, is in service. The claim has been in operation fourteen years, and is worked only during the day, by five hands. White employés receive $1 50 per day and board; Indians, 75 cents to $1.

SCOTT RIVER.

The Klamath River enters Humboldt County at its junction with the Salmon, one mile and a half from Somes Bar. Up to within four miles of that point the terraces, or benches, have been followed seventy miles from the place where they first make their appearance at the mouth of Scott River, and they extend along the line of the Klamath thirty-one miles above, where Cottonwood Creek intersects that river. The class of mining work described has been confined mostly to wing damming the river bed.

It will be in order now to take up the several Klamath tributaries, and describe their gravel deposits. Scott River is one of the most important. It enters the Klamath in Sec. 6, T. 45 N., R. 10 W., M. D. M. Elevation above the sea level, one thousand six hundred and fifty feet. Its extreme length, following the contour line, is sixty-one miles, and average course, from source to mouth, north 20 degrees west. Its tributaries span twenty-six miles, fed by a watershed of eight hundred and twelve square miles. The Scott flows through the mineral districts of Oro Fino, Quartz Valley, and Callahan's. Although the river bed has been pretty well exhausted, there are a number of companies yet working on back and parallel chan-

nels somewhat deeper, using the pump, Bull, and dip wheel, as previously described in the wing dam system. These claims are paying a little over wages.

The Remus Hydraulic Placer.

This is the first claim of importance, and embraces forty acres covered by United States patent. Here are two well defined benches or terraces with work enough done upon them to prove their value. The claim, however, is not handled upon the hydraulic plan for want of water; until a sufficient supply can be procured, the first bench will be worked by the drift methods.

Scott River Mining and Canal Company.

About three quarters of a mile from the river's mouth is Whiting Hill, formerly subdivided into a number of claims now consolidated under the title that leads this paragraph, and incorporated. It is an important property; has a frontage of two thousand five hundred and forty-one feet on the river and extends backward two thousand five hundred feet to the dividing ridge. The company owns a franchise that controls the waters of several tributaries to the Scott River, a distance of twenty miles. The franchise includes Tompkins, Middle, Kelsey, and Cañon Creeks, as well as the Scott River itself. The claim has three well defined terraces similar to those before described, varying from fifty to four hundred feet in height. The principal work done is on the lower bench, fifty feet above the river bed, in which five cuts have been driven across the channel, all in pay gravel, some of it very rich, where the inner rim rock was reached and a raise made. This proved that the vertical height was ninety feet before the pitch, or dip of another channel was reached. The drift was then extended three hundred feet in gravel with good prospects, but finally discontinued for lack of ventilation. The other five cuts or drifts have simply penetrated the front channel. Stoping was attempted at several places, but without much success, as the ground could not be kept up, and extensive caves occurred, some to the height of twenty or thirty feet. Work was therefore abandoned. The caved gravel was wheeled out, washed, and found remunerative. From these workings, and attempts to work, it is stated that gold to the amount of $204,000 was extracted.

The lower workings, called the Bamboo, proved to be a natural outlet or break in the channel. At this point, the present company commenced the season with a full hydraulic rig, but their canals and flumes not being completed, and the water season short, only sufficient work was done to test the gravel, and it was suspended after a short run. The yield was 40 cents per cubic yard. Scott Bar is the nearest town to the claim, being distant three quarters of a mile in a northeasterly direction. The width of gravel from rim to rim in the first channel is three hundred feet; in the second and third channels the width has not as yet been ascertained. Height of banks, one hundred and twenty-five to one hundred and fifty feet, and thickness of the gravel from the bedrock (which is schistose slate) up, is thirty to fifty feet. In character it is pebbly, with some pipe clay, a little cement, and but few large bowlders, excepting on the bedrock, and pays 44 cents per cubic yard. Length of sluices, two hundred feet; size, five by three feet; grade, seven inches to the box of twelve feet. Rocks and wooden blocks are the riffles. Of the percentage of recovery 80 per cent is saved in the sluices and 20 per cent in the under-current. Water flows to this claim in a flume of four miles in length, connected with a ditch fourteen miles long. The former is three eighths of an inch in grade to the rod, the latter being the same for a like distance. The

ditch and flume have a capacity of two thousand five hundred miner's inches, and a pressure head at the benches of six hundred feet. The claim is worked by day and night, the lighting, when needed, being furnished by electricity at a cost of $1 per night. There are two thousand feet of Nos. 12 and 14 fifteen and eighteen-inch pipe, and a Giant with four and six-inch nozzles upon the property. Two flasks of quicksilver have been used this season. There are twenty-two men employed on the property, with wages per day, for whites, $2 50; for Chinese, $1 25.

SCOTT BAR.

Two miles from the southerly end of the claim just mentioned, Scott Bar is reached—a spot celebrated in former years for its rich placer fields. Some virgin ground yet remains under the town, portions of which are regularly worked every season. The high bars, terraces, or benches above the town are drifted, there being no water for hydraulic purposes.

Joseph Beeler's Placer and Drift Claim

Is said to be paying well, with four men employed. It is one hundred and fifty feet above the river bed.

The McGuffy Drift Claim

Is on the first bench, seventy feet above the river bed. He is working in a channel one hundred feet wide from rim to rim, with good results.

Reynolds & Jacoby's Claim.

One mile and a half further up the river, on Skunk Hill, this forty-acre claim is being worked by the hydraulic plan, through eight hundred feet of fourteen-inch iron pipe, by a No. 2 Giant, with a four and a half-inch nozzle. The height of the gravel bank is one hundred feet, against which six hundred inches of water are directed with a pressure head of one hundred feet. This claim is four hundred feet above the bed of the river on the third bench or terrace, and the work, so far, shows a channel one hundred and seventy-five feet in width, with the bedrock still pitching into the hill. This claim has been worked for several years. At a point just above, the river cuts through the terrace or bench system, which is traceable for a long distance in a southeasterly course, but the ground in this direction has not been disturbed.

THE ORO FINO MINING DISTRICT

Twenty-two miles (if the course of the river be followed, but only ten miles in an air line) southwesterly from Scott Bar, the mouth of Shackleford Creek, at its junction with Scott River, is reached. Here is the Oro Fino Mining District, comprising the valley of that name and also Quartz Valley, which are separated from each other by a low line of mountains, or rather hills, known as the Oro Fino Range. On both flanks of these eminences, and extending into the valleys, are large areas of placer ground but little developed, those worked being on the outskirts of gulches or the tributaries to main streams, and then only to a depth of from ten to sixty feet; while the center of the main channel, as yet undisturbed, is from one hundred and fifty to two hundred feet deep.

The auriferous dirt is evidently derived from the erosion and decomposition of the mountain sides in the immediate vicinity, as but few pebbles or gravel that shows the action of running water or wash are found intermixed. Neither are there any large bowlders worn smooth by attrition.

The average fineness of the gold in this district is 785. Hydraulic washings have shown, so far, the yield per cubic yard of gravel to be from 75 to 83 cents. The natural grade from the dumps to Scott River is not sufficient to carry off the debris, and it has to be supplemented by the closed hydraulic elevator system and open boxes.

EASTLICK BROTHERS' HYDRAULIC CLAIM

Consists of thirty acres of ground under United States patent, of which twelve acres have been exhausted. The part worked yielded (as per statement of the owner of the property, verified by certificates of the San Francisco Branch Mint) from an area one hundred and fifty feet wide by three hundred feet long and thirty-five feet deep, as follows: Result of drifting (original working), $15,000; result from hydraulic, $24,700; total, $39,700. By the hydraulic plan the bank is undermined and caved by the force of the water from a Little Giant under a pressure head of two hundred and seventy-five feet. The gravel from the cave is washed into a pit at the mouth of the elevator, on which a No. 2 Giant with a four-inch nozzle plays water supplied through a fifteen-inch pipe under a pressure head of one hundred and seventy-five feet, forcing the gravel up an inclined plane in an open top box flume at an angle of 45 degrees to a height of sixteen feet. This elevator is lined with blocks of wood, and the inside dimensions are two by three feet; length, thirty-two feet. As before stated, this artificial lifting furnishes grade sufficient to carry the debris to Scott River, a distance of three miles, where the current is strong enough to prevent its filling up and clogging the channel.

The claim is located on Oro Fino Creek, a tributary to Scott River, at an altitude of three thousand feet above sea level, and measures thirty acres, with half a mile frontage on the creek. Oro Fino is the name of the nearest town. The gravel from rim to rim is three quarters of a mile wide, and the course of the lead or channel north and south. The banks are from ten to fifty feet high, but pitching into the channel. All the way up from the bedrock, which is of talcose slate, the pay gravel is good. It is earthy in its nature, formed by the decomposition of the mineral belt and erosion from the sides of the mountain chain. In shape the particles are more angular than spherical, and there is no clay nor cement. The pay is about 55 cents to the square foot of bedrock. A block one hundred and fifty feet wide by three hundred feet long, and thirty-five feet deep, was removed in sixty-five days, which paid $24,700. Length of sluices (below elevator), one thousand one hundred feet; size, thirty-two-inch bottom and twenty-inch side; grade, seven eighths of an inch to a twelve-foot box. Wooden blocks, twenty by six inches, are used for riffles. The ditch is four and one seventh miles long, with a right of way through the creek to Scott River. The source of the water is Kidders and Evans Creeks. The quantity of water used is three thousand inches, under a pressure head of two hundred and seventy-five feet. The claim is worked by a shift of three men during the day and the same number at night (pine wood, at a cost of $1 25 from night till morning, being burned for lighting). Two No. 2 Giants are used, with two, three, four, and five-inch nozzles, and two thousand feet of six, twelve, and fifteen-inch pipe. Two flasks of quicksilver are in use, with a

loss of 25 per cent for the season, which only lasts from two to three months. The hands receive $2 50 per day.

WRIGHT & FLETCHER'S HYDRAULIC CLAIM

Adjoins the Eastlick property, and is similar in nearly every respect, producing the same pro rata results, water and pressure head considered. The same hydraulic elevators are in use. One No. 1 Giant, two thousand two hundred and eleven feet of fourteen and sixteen-inch pipe, are in service, with a two hundred-foot pressure head of water. The water is brought from Kidders Creek in a ditch four miles long.

From this point to the mouth of Scott River, a distance of three miles, the ground is all claimed as mineral land. Superficially it presents equally as promising an appearance as that already developed. The width of the valley at this point is five thousand feet.

QUARTZ VALLEY MINING AND STOCK-RAISING COMPANY.

Crossing the Oro Fino divide in a southwesterly direction, Quartz Valley is entered about two miles distant from the town of Oro Fino, where is located the property incorporated under the above name. It consists of one thousand three hundred acres, one thousand two hundred of which is covered by United States patent. A part of the claim is worked on the hydraulic plan through open cuts; but a portion, with not sufficient grade to carry off the debris, is treated differently. The gravel is, of course, first thrown down by hydraulic force, then elevated by the same power to a height to secure sufficient incline to the main river. The property is situated in T's. 43 and 44 N., R. 10 W., M. D. M. The mine proper is on Shackleford Creek, a tributary to Scott River, and the valley is one mile wide by five miles long. From surface to bedrock rich alluvial gravel is found, the central depth in mid-channel being from one hundred and fifty to two hundred feet, judging from the inclination of the bedrock on the sides and rim of the channel proper. Only the more elevated portion of the ground has been worked, as the general grade is insufficient. Even in the higher workings it is found necessary to use the hydraulic elevator; by this means large areas have been worked that otherwise could not have been handled without drifting. The gulches and ravines that make into Shackleford Creek have proved to be rich. Gravel taken from a depth of from thirty-five to sixty feet on the claim under notice, has paid 30 cents per cubic foot. During the ten years this claim has been worked by the present owners, it has yielded $200,000 from the exhaustion of about eight acres, and the company in possession previously took out about $100,000.

The season is confined to four months and a half in each year, but a great quantity of water runs to waste that could be saved by proper reservoirs. During the water season four thousand inches are delivered at the mine by four different ditches. The pressure head used for elevation is two hundred and forty feet, requiring the force of one thousand inches. Of the four ditches two are twelve miles and two are two miles long. The sluice or main discharge flume is about fifteen hundred feet long by six feet wide, and riffled with eight-inch blocks. The flume has a grade of one inch and a half to each twelve feet, which, by the volume of water used, and the light character of the gravel deposit, separates and lodges the gold freely in the riffles. On the elevator a twenty-two-inch pipe with a six-inch nozzle is used, and the material is lifted thirty-eight feet by two Giants, running under one hundred and fifty feet pressure head, with an eighteen-

inch feed pipe, and three and a half and four-inch nozzles. The surplus water is conducted to the main sluice or flume, to assist in carrying off the debris. A thirty-inch sluice carries the material to the elevator from the Giant, the grade to the twelve-foot box being five inches. Water to supply this claim is taken from Shackleford, China, Kidder, Beaver, and Mill Creeks. Work is pursued by day, and at night by means of electricity. A dynamo sustains three lamps at a cost of $2 per night. From twenty to twenty-five men are employed, at an average wage of $2 50.

STOCKTON GRAVEL MINING COMPANY.

The claim of this company lies in a southerly direction from the above, and embraces an area of one hundred and ten acres, eighty of which are under United States patent. It is located at the head of Pinery Creek, tributary to Mill Creek, with its source in Douglass Hill. Here, running longitudinally, the same formation of terraces, or benches, found on the line of Scott River, ten miles distant, reappears. Some $20,000 has been expended in driving adits through the rim rock, but, so far, none have been low enough to accomplish the object designed.

The Stockton claim embraces all the upper end of the valley, and has been prospected by shafts and drifts three hundred feet on the channel, and forty-two feet wide. Work was discontinued owing to an influx of more water than could be controlled without expensive machinery. The purpose of the present company is to open this ground by a drain tunnel (adit level), and contracts have been let to a company of Chinamen for five thousand two hundred feet of it, four by five and one half feet, at $1 12½ per foot. Two thousand six hundred and sixty-three feet have been completed to date. Shafts, for ventilation, are raised every four hundred feet. A novel and interesting feature in the hydraulics of this adit is that it is driven on a dead level, with a fall, or "draw," at the mouth of only six feet, vertical, on an inclination of 45 degrees, to accelerate the flow of water. At the time of our visit, the water stood on the floor of the adit to the depth of eight inches, but did not interfere with the progress of the work. During the winter season, the flow (estimated) from the mouth of this tunnel is three hundred inches. Another feature of interest in this ground is that the gold taken from old workings at the head of the flat averaged 900 fine, was nuggety, and smoothly surfaced, showing that it had had its origin elsewhere, probably from the ancient river channel referred to, on the Douglass Hill divide.

THE LAST CHANCE.

Twenty miles distant southwesterly, in an air line, Callahan's Ranch is reached, near the forks of Scott River, where this claim is located, with a frontage of one hundred feet on the river bed. Preparations are being made to work it by wing dam.

MONTEZUMA PLACER CLAIM

Is located one mile and a quarter up the South Fork of Scott River on Montezuma Flat. It embraces an area of eighty acres under United States patent, with a depth of gravel to the bedrock of twenty-five feet. One half of this ground has been worked with satisfactory results by means of a wing dam. Eight men are employed.

PETERSON & POLLARD'S PLACER CLAIM

Is the next above, with six hundred feet of river frontage, and is situated on a high bar.

A. B. C. CLAIM

Is on a tributary to the South Fork known as Fox Creek. It is a drift claim worked by four men with but meager results.

HYDE HYDRAULIC CLAIM

Comes next in order, with forty acres of ground worked by eight Chinamen and three white men. It pays a small surplus over expenses.

THE SUGAR HILL CLAIM

Follows on Fox Creek. It contains twenty acres and is worked by drifting, with some system, and with good results. There are longitudinal drifts in the center of the channel, with gangways and breasts.

THOMAS ABEE.

The next and last of any importance on the South Fork is a claim with this name, having a river frontage of nine hundred feet. It is worked by four men, and the drifting done through three tunnels. The gravel is not rich.

ON THE SALMON RIVER.

A description of the principal gravel claims on the Salmon River follows, in proper order, the information given concerning those on the Scott and its tributaries. The Salmon is taken up at its confluence with the Klamath in Sec. 4, T. 12 N., R. 6 E., M. D. M. Its course is southwest, and, as a tributary to the Klamath, it is one of the most important, being fed by an extensive watershed of seven hundred miles. It receives the water of the Independence Creek Divide and the Salmon Range on the north, the Salmon and Trinity on the east, and the Trinity and Orleans Mountains on the south and southwest. From northwest and southeast its extreme length is forty-two miles, and the extent of its tributaries from north and south thirty-two miles. Some of the Salmon tributaries form rivers of no mean proportions in themselves, and the volume of water that finds outlet through it into the Klamath can be estimated by the fact that during the freshet of 1862 it rose, at the point of junction, one hundred and two feet above low water mark.

Commencing at this point, mining properties will be described as they occur on the main river and its tributaries. Two miles southeasterly Somes Bar—a distributing point for this section—is reached. This village has a supply store, hotel, and Post Office.

McNeal's Hydraulic Claim

Lies distant eighteen miles. It measures fifty acres, and is worked by four men day and night. One thousand miner's inches of water, under a pressure head of seventy-five feet, are taken from Nordheimer Creek. The bank on the second bench is fifty feet high, with twenty feet of rich gravel.

The Crapo Gold Mining Claim

Is half a mile further on the east side of the river. It consists of one hundred and sixty acres on a terrace bench two hundred feet above the river bed, with a one hundred-foot bank, twenty-five feet of gravel, and one hundred and fifty-foot dump. Water is taken from Crapo Creek through one mile of ditch with a capacity of one thousand five hundred inches, miner's measurement, under a head of one hundred and fifty feet. Size of ditch, four feet wide, three feet high, and a grade three quarters of an inch to the rod. The claim pays dividends.

Haley Gold Mining Company

Has a sluicing claim on a low bar next to the one just mentioned. It is worked by water from Crapo Creek. Output unknown.

Spooner & Co.'s Claim

Adjoins on the second bench. It has an area of twenty acres, and is hydraulicked. Water is taken from the North Fork of the Salmon.

F. Brazil & Sons

Have a claim of forty acres on a terrace, or bench. The bank is fifty feet high, with twenty feet of rich gravel; but the water supply is irregular.

The Holmes Hydraulic Claim

Is next above the Brazil's, a location of fifty acres of hydraulic ground, with a forty-foot bank and a twenty-foot dump. Four men are employed here.

The Bloomer Hydraulic Claim

Is the next above on the southwest side of the river, at an altitude of one thousand four hundred and seventy feet above ocean level. In area it is one hundred and sixty acres, and is located on the second bench above the river bed. At this claim a bedrock tunnel has been driven through the rim rock and into the channel for a distance of four hundred feet. This claim was opened through a pit; the first half acre yielded $6,000, as per owner's statement, with a net profit for the sixteen years worked of $40,000. Nearest town is The Forks, or Bennetts, northwesterly two miles. The claim has three benches, respectively fifty, two hundred, and four hundred feet above the river bed. Frontage on the river, one mile. Width of gravel, three hundred feet; thickness of gravel from the serpentine bedrock up, from twenty-five to thirty feet; height of banks, eighty feet; the character of the gravel is small pebbles, not heavy, and with but few bowlders. Length of sluices, two thousand four hundred feet; size, twenty-eight by thirty inches; grade, eight inches to twelve feet; riffles, wooden blocks. There is also one undercurrent sixteen by forty-eight inches, placed at a grade of sixteen inches. The flumes are four miles in length and carry one thousand miner's inches of water taken from Nordheimer Creek. The claim is only worked in the daytime by five hands; there are two No. 2 Giants, with three and four-inch nozzles, and two thousand feet of fifteen and eleven-inch pipe, No. 16 iron; pressure head, two hundred and twenty-five feet. Five boxes of No. 1 Giant powder have been consumed during the season, and one flask of quicksilver has been in use, on which there is a loss of 25 per cent. The wages paid are $2 50 per day.

"THE FORKS."

At a distance of two miles from the claim last named the Forks of the Salmon are reached. The village with this name is an important distributing point for this part of the country, and has a large supply store filled with general merchandise, a hotel, Post Office, etc. Taking the South Fork of the river from this place, and following it to its source, the outlets of Knownothing and Methodist Creeks, important for their quartz interests, are passed, and Yocumville, a trading post, reached, at an elevation of one thousand five hundred and forty feet above the level of the sea. There are no important mining operations for seventeen miles on the South Fork. At Yocumville the river again forks; the East Fork of the South Fork takes a northerly course, while the main fork flows southwesterly. At the junction, at Cecilville Bar, which is two and a half miles long, with a proportionate breadth, there is a gravel deposit forty feet high, and preparations are being made for a ditch to take water from the northerly fork. Following the South Fork for a further distance of six miles beds of auriferous gravel are passed, lying untouched, as well as veins of gold-bearing quartz.

Summerville Hydraulic Claims.

This is the only important property in active operation on the South Fork. There are nine hundred and ninety-five acres, including Petersburg Flat, and taking in the river bed and both the banks for four miles. The height of the gravel beds varies from ten to seventy feet, with from ten to twenty feet of gravel on the bedrock. The larger portion of these gravel deposits is underlaid by talcose slates, which flank the granite forming the axis of the Trinity Range of mountains. From this point to the source of the river is seven miles, with a nine-mile sweep from north to south that makes the watershed. The supply of water during the summer is drawn, however, from melting snows and living springs, at an altitude of seven thousand feet. There are also on the divide a number of small lakes, and it is proposed to tap these, and so increase the quantity of water already at command.

The origin of the gold found here is undoubtedly local, as the particles are not rounded, nor have they a water-worn surface. Mountain streams have eroded the rocky formation, and laid bare numerous stringers and veins of gold-bearing quartz. The Summerville claims are at Spoonerville, one mile above the place from which they derive their name, in the Salmon River Mining District. The nearest town (Forks of Salmon) is distant twenty-five miles. There are two benches on these claims respectively forty and one hundred and fifty feet high, and the course of the channel is east and west. The width of gravel is four hundred feet; thickness of the bank from the bedrock up, ten to twenty feet. Its character is fine wash, with no bowlders. Where working at present the bedrock is porphyritic. The pay is said to be from $2,000 to $3,000 per acre. The last yield was given as $16,000 per acre. Length of sluices, six hundred feet; size, twenty-eight by thirty inches; grade, six inches to twelve feet of box; the riffles used are wooden blocks and iron bars.

The quantity of gravel mined during the season is one acre. The claim is worked day and night with four Giants, three No. 2 and one No. 5, the nozzles being one five-inch, two four and one half-inch, and one four-inch; with six hundred feet of eight and fifteen-inch pipe of No. 6 iron. There are two ditches. The one on the river is six miles in length, and that on

Rush Creek one mile and a half. Size of the river ditch, six by four by two and a half feet; creek ditch, eight by six by two and one half feet. Grade of the river ditch, three and one quarter inches to the rod; of the creek ditch, one half inch to the rod. The quantity of water used, in miner's inches, is four thousand inches—two thousand from the river, and an equal quantity from the creek. It is taken from the South Fork of the Salmon, Little South Fork, and Rush Creek, and is owned by the proprietor of the claims. The sources of supply in reserve are two lakes, one half a mile in diameter and the other three quarters of a mile long and half a mile wide. Work may be carried on for a season of ten months. With the additional supply to be derived from the lakes the working season will be extended to twelve months. Five boxes of Giant powder are consumed during the year, and two flasks of quicksilver are used, the loss on the latter being 20 per cent for the season. Fourteen hands, including cook and foreman, are employed; the latter receives $100 per month. Average wages: Whites, $2 50; Chinamen, $1 50.

THE CARIBOU.

[The description of Siskiyou's gravel claims is interrupted here, to mention that, at twelve miles distant from Spoonerville, a quartz mine called The Caribou is being worked. The vein is forty feet, between walls of granite and slate, with a strike north 20 degrees east, and dip easterly 40 degrees. It is worked through a shaft thirty feet deep. The ore is crushed in a two-stamp mill belonging to the property, and yields $8 per ton. Within a radius of five or six miles in this vicinity, there are quite a number of quartz veins that give good "horn prospects," but as yet little if any development has been made. This fork of the Salmon heads in what is known as Big Flat, which contains an area of six hundred acres. The central point of the flat is on the boundary line between Trinity and Siskiyou Counties, six miles from Summerville. Apparently, this flat was the bed of a lake at one time, or the channel of a river, as below the surface auriferous gravel is found, lying at a depth of from fifty to one hundred feet, and of a very rich character. The entire area has been located as placer ground, and is being worked by drifting, entering from Coffee Creek, a tributary to Trinity River, in the county of the same name. It is reported that the gravel on the bedrock pays from $30 to $180 to the set of timbers, or cap, four by six feet.]

The Shumway Brothers' Claim.

On the North Fork of the Salmon River is the claim with this name, having a breast of seventy feet. The water is brought in by flume from the river above during the winter months, when the work is prosecuted on the hydraulic plan with one Giant. The pressure head is light. In the summer they resort to drifting. Two men are employed, and the yield is said to be $8 per day to the hand.

Roff Hydraulic Placer Claim.

The claim named is being worked on the second bench above the river bed. The bank is about two hundred feet high, with from twenty to thirty feet of gravel. It is worked by one thousand inches of water, with a five hundred-foot pressure head through one Giant.

The Suroni Hydraulic Claim

Is situated six miles above the Forks, and contains twenty acres of ground covered by United States patent. One half of this extent has been exhausted. The claim shows four well marked terraces, or benches, of the old river channel. The bank of the river slopes at an angle of 25 degrees to 30 degrees. A line drawn from the river bed to the top bench would measure one thousand three hundred feet. The nearest town to the claim is the Forks of the Salmon, distant six miles in a southwesterly direction. The claim fronts eighty rods on the river, and the course of the lead or channel is southwest and northeast. The benches vary from seventy-five to two hundred feet in height, and the width of gravel from rim to rim may be marked by the same figures. Height of banks, one hundred and fifty-five feet. Thickness of gravel from the slate bedrock up, twenty feet. The gravel is "light wash." Length of sluices, three hundred and fifty feet, thirty by twenty inches; grade, eight inches to the box of twelve feet. Wooden block riffles are used. There is a good supply of water in the wet season, but no flow in the dry. The capacity of the flume is one thousand miner's inches, with a pressure head at the benches of two hundred and twenty feet. The flume is one quarter of a mile long, twenty by eighteen inches in size, and with a grade of four inches to the rod. One No. 2 Giant is in play, having a three and a half inch-nozzle, with nine hundred feet of No. 18 thirteen-inch pipe. Five boxes of Giant powder are consumed during the season of from five to seven months, and one flask of quicksilver required, on which there is a loss of 40 per cent. From one to three men are employed at a wage of $2 50 per day. The claim is not worked at night.

Ork Hydraulic Claim.

Next in order is this claim, with a bank forty feet high, carrying twenty feet of gravel. Four hundred inches of water, with a pressure-head of one hundred and twenty feet, are used, and one Giant, with one thousand feet of pipe. It is reported as a paying claim.

The Red Hills Claim

Comes next. It is in T. 40 N., R. 12 W., M. D. M. The claim consists of twenty acres under a United States patent title. There is a bank one hundred feet high, with fifteen feet of gravel, which, worked by the hydraulic method, pays 15 cents per square foot. Seven hundred and fifty inches of water, under a pressure head of one hundred and twenty feet, are used. Half an acre of ground per month is removed. One thousand feet of iron pipe, No. 18, is in service, and eight men are employed.

Opposite the Red Hills an extensive claim is being opened up on the river bed by a wing dam. The first section that will be worked consists of twenty acres of the river bed and its banks.

The Ahlgren & Lasselle Claim.

Next above, is a claim with this name, on which a fifty-foot bank, with twenty feet of gravel, is being worked. The ditch is five miles long; eight hundred feet of fourteen-inch pipe and one Giant are in service. Seven hands are employed. The claim is reported to be paying. Last season (seven months) the clean-up is stated at $5,000. It is known as "The Quicksand Claim." Eight men are employed.

Gustave Rellanor & Co.'s Claim.

Above the Quicksand, on the river proper, this claim is being worked by a wing dam, with the usual accompaniments of machinery. A pit has been sunk, and work for the season is in a good state of forwardness. Eight men are employed day and night.

Deep Channel Claim.

This claim, adjoining, is also worked by wing dam. Five men are employed. The claim is reported as paying well.

G. A. Moore & Co.'s Claim

Is also a wing dam in the river bed. Four men are employed.

Steamboat Hydraulic Claim,

On the river bank, above, has forty feet of bank, one Giant, water supply and head pressure light. Season short.

Adjoining is the Whistle Bar, a river claim, worked by a wing dam, with four men.

The next above, on Paradise Flat, is a drifting claim in the back channel of the river, employing three men. Gold, coarse and "nuggety." It is reported that the claim pays from $4 to $8 per day to the hand.

SAWYERS BAR.

This town is situated at an altitude of one thousand one hundred and twenty feet above sea level, and is the principal one in Liberty Township, comprising all that area west and south of the Salmon Range of mountains to the Humboldt County line. It is nineteen miles distant from Etna, from which it receives its mail and general supplies by saddle horse and mule train, over the Scott Mountain trail.

Above this point, easterly, quite a number of river claims are being worked during the summer season; but none with marked success. An hydraulic claim, one mile east of the town, is, however, reported to be paying. On Eddy's Gulch, several claims, bank and river bed, are being worked whenever water can be had. The ground is rich, and, when well handled, is said to pay well. Klamath and Black Bear Ranges cross the river's head, and from these sources comes the gold found in the channel and on the banks.

JOHN W. HARRIS HYDRAULIC CLAIM.

This claim is located on the North Fork of the Salmon, five miles above Sawyers Bar, and embraces one hundred acres. The workings are on the second bench, where a bank of from ten to thirty feet of gravel pays (as is reported) $10,000 to the acre. Water is supplied from the North Fork by a ditch four miles long, the capacity of which is three thousand miner's inches, with a pressure head of one hundred and eighty feet. One Giant is in service, with two nozzles two and one half and three inches, and six hundred and seventy-four feet of thirteen and eleven-inch iron pipe.

THE BURNS HYDRAULIC CLAIM.

This claim is in operation one mile easterly from Sawyers Bar on Eddy Gulch. Its area is seventeen acres, worked by four men with one Giant (four-inch nozzle), and eight hundred feet of pipe. Height of the bank thirty feet, with ten feet of pay gravel. Reported paying.

ANDERSON GRAVEL CLAIM.

This adjoins the above, and is drift ground eighty acres in extent, worked by four men, and realizes, according to statement, $15 to $20 a day per hand.

THE CASEY SLUICING CLAIM.

This property, next to the Anderson, contains twenty acres. Two acres of the gravel worked paid $8 a day to the hand, according to statement. Water not obtainable during dry season.

THE FRANK MANGAYAN CLAIM.

This is above the Casey. Its extent is twenty acres, and the working is conducted by four men with one No. 2 Giant (four-inch nozzle), and three hundred feet of pipe. The bank is from twenty to sixty feet high, all in pay.

Above those mentioned, are three claims, sluicing and drifting, that can only be worked during the rainy season, and their productiveness varies, therefore, with the greater or less supply of water.

AN EXTENSIVE UNDERTAKING.

On the Klamath and Salmon Rivers in this county there are extensive areas of mineral land, on which the hydraulic might be used to advantage. Those areas have been located, and are now held by men who have no means to work them; consequently they have not been utilized. Seeing this condition of things, a syndicate of the county's capitalists has been formed to develop the ground, and by purchase, contract, and location has, so far, acquired control of forty thousand acres of river bed and banks, all alluvial ground, as well as secured in connection extensive water rights and privileges. Careful surveys have been made, and others are in progress, with the view of cutting ditches and canals to secure the ample and never-failing supply of water needed by such an important enterprise. One portion of this property, Summerville Hydraulic Claim, situated on the South Fork of the Salmon, is already in operation, and its working is fully described in this report.

IN SCOTT VALLEY.

On leaving the Liberty District and the waters of the Salmon, Salmon Range was recrossed and Scott Valley entered, following the creeks tributary to Shasta and Scott Rivers.

Indian, Yreka, and McAdams Creeks have large areas of productive placer ground now being worked. The first creek named is tributary to Scott River, and rises in the Deadwood Range. From its source the valley gradually expands, until the soil and gravel reach a width of from six hundred to eight hundred feet, and a depth of from thirty to one hundred

feet. Shafts have been sunk, and this ground is now worked by drifting. The Owens & Sill gravel claim controls one mile of the creek's bed, which is eighty yards from bank to bank. Yee & Co., a Chinese company, are the present owners. There are twenty-two Chinamen employed, who run two derricks. The drain tunnel is seven thousand feet long, and cost to run 97 cents per foot. Hop & Co. work forty-five acres in the flat or creek bottom with twelve men; output unknown. A claim of eighty acres (patented ground) near by works six men, and another with ten acres works four. This last claim has a channel seventy feet wide and eight hundred feet long, with three hundred feet of drain tunnel. It carries five and one half feet breast in gravel, with twelve inches of bedrock, using single posts and caps in the breast. The gangways are thirty feet wide. The bedrock is soft and black, with serpentine. Some cement is encountered, which is crushed, and, according to mill returns, pays $13 per ton. The workings are forty feet from the surface. Forty inches of water are used for hydraulicking. There are several other claims of lesser note being worked on Indian Creek.

McAdams Creek is a branch of the Moffat, tributary to Scott River, and takes its rise in the Forest Mountain Range. The placer ground on this creek is well spoken of from its source to its junction, a distance of eight or nine miles. The valley expands and the soil deepens so rapidly that it was found impossible to work the ground without machinery, or a bedrock tunnel for drainage. Inefficient machinery, employed for development, resulted in a failure. Now, in the hands of new people, holding more capital, work is progressing with prospects of success. The new organization is known as the Steamboat Company.

Yreka Creek is tributary to the Shasta River, and has, of yore, been an important gold producer. There still remains in Yreka Valley, near Hawkinsville, two miles below the county seat of Siskiyou, a large area of auriferous ground, as yet comparatively undisturbed; for the reason that the same trouble (depth of surface ground before the gravel is reached, and difficulty of drainage) that exists on McAdams Creek will here attend development. Several attempts have been made, at heavy expense, with the hydraulic elevator; but the outlay was so heavy that nothing came from these experiments, and therefore further trial was abandoned. The creek, at this point in the valley, is fed by several tributaries, and the ground thereabout is said to be rich. Here the valley is from one to two miles wide.

The few placer claims here that are worked have Portuguese and Chinese to operate them. Hick, Wash & Co. own twenty acres of patented ground, regularly worked for the past twenty years. This claim sends its owners home to the Flowery Kingdom with a considerable fortune every two or three years. The property regularly changes hands in that space of time. The gravel on this claim is about twenty feet deep. The water is taken from Greenhorn Gulch, which has a flow of eight hundred inches, miner's measurement, for seven months. During the remainder of the year it is bought from the Big Ditch, the principal source of supply for this region. The Chinese company own the right to the Greenhorn Gulch water.

THE QUARTZ MINES.

At a point near the head of Eddys Creek is found a belt, or rather a vein, in place, known to miners as "black slate," coursing north 20 degrees east and south 20 degrees west, lying between walls of quartzite on the west, a porphyritic rock on the east, and dipping east at an angle of 20

degrees. This slaty formation contains lenticular and kidney-shaped deposits of auriferous quartz, often forming extensive bodies of ore varying in richness. Running though the center of this slate we find a denser body of rock, slaty in structure, known as anamesite, which separates the quartzose material, and apparently forms two veins, similar in many respects to the parallel vein system of the mother lode in Amador County, where they are known as the bowlder and main mother lode. This vein formation runs diagonally through the Blue Ridge.

On the westerly side or slope there is much displacement; the whole formation has slid from its original position, causing faults and irregularities that have been difficult to follow in working the mines. The owners have been involved in heavy loss, notwithstanding the output exceeded $500,000. On the eastern slope of the ridge, as shown in the Black Bear Mine, there is no displacement. Lying parallel with the black slate vein formation there are several veins of auriferous quartz, with the ore in well defined shoots, which pay almost uniformly from the croppings down.

THE HUMPBACK.

The first quartz vein demanding attention is that on which the Humpback is located, one thousand feet west of the Klamath River, in Eddy Gulch. The tunnel on this mine is one hundred and eighty feet, the shaft eighty. Vein is from six to twelve inches wide; the course, north 20 degrees east; dip, east 80 degrees. There is a regular shoot, sixty feet long, dipping north. The ores are worked in an arrastra.

UNCLE SAM.

Thence, about two miles northeasterly from the Klamath River, at an elevation of four thousand three hundred and eighty feet above the level of the sea, between White and Eddy Gulches, near the summit, and lying parallel with Black Bear and Klamath Rivers, easterly, are the Uncle Sam Gold Mining Company's works. The mine is in Liberty District, and the lode is one thousand five hundred by six hundred feet long; course, north 20 degrees east and south 20 degrees west, with an easterly dip of 25 degrees. The formation includes vein slate and porphyry. This mine has been in operation for the past twenty years. Water is the motive power, supplied from White Gulch. Few hands are worked, as the season does not last longer than four months. The gold produced sells at $18 50 per ounce.

Summary.—Length of ore shoot, 110 feet; vertical depth reached, 300 feet; hanging-wall, porphyry; foot-wall, slate; powder used per month, Giant, 250 pounds; cost per ton for mining, $1 50; cost of tunnel per foot, $5; cost per foot of shaft, $10; both timbered with fir, which cost 5 cents per running foot; road built, 3 miles; ditch, 3½ miles; ore, friable, rose-colored quartz; mill, 8-stamp; weight, 780 pounds each; drop, 7 to 9 inches; drops per minute, 95; white iron shoes and dies, working two tons in twenty-four hours per stamp; screens, flat punched, No. 8; apron, 18 by 32 inches; water in battery, 2 inches; length of sluice, 48 feet; feed, hand; percentage of gold recovered in battery, 80; on plates, 20; percentage of sulphurets, 2; cost of milling per ton, $1 50; total number of men in mine and mill, 5—all joint owners.

MOUNTAIN LAUREL.

Returning to a lower level, at a point one mile and a half from the mouth of Eddy's Gulch, this mine is reached. It is at an elevation of three thousand eight hundred and forty feet above sea level, and was located in 1862. The ground, consisting of one thousand five hundred by six hundred feet, is covered by United States patent. It lies on a branch of

the South Fork, in Liberty Mining District, four miles from Sawyer's Bar. This property, with the Klamath Mine and its plant, was purchased one year ago by the Gold Ball Mining Company, an eastern incorporation, who proceeded to develop it. The mine has been opened by four levels driven into the vein from the surface on the inclination of the lode (in places very flat) with winzes to connect the several openings. It is found that the vein varies very much in size, say from four inches to eighteen feet, and is considerably disturbed and broken. The ore, as estimated by the owners, will yield $10 per ton.

Summary.—Length of ore shoot, undetermined; ore shaft on the incline, 120 feet; depth reached vertically, 80 feet; hanging-wall, black slate; foot-wall, hard, gray slate; kind of powder, Giant, but little used; cost of mining and milling, $3 25 per ton; kind of timber used in tunnel, fir; cost of timber, 4 cents per running foot; cost to run tunnel, $6 per foot; length of road built, 3 miles; cost to transport ore, 25 cents per ton; character of ore, friable quartz; number of stamps, 16; duty of stamp, 1½ tons in twenty-four hours; kind of feeder. Percussion; weight of stamps, eight, 650 pounds each, and eight, 750 pounds each; drop of stamps, 80 per minute; kind of shoes and dies, white iron; kind of screens, No. 11 slot punched; dimensions of apron, 18 by 32 inches; water used in battery, 2 inches; width of sluice, 18 inches; length of sluice, 6 feet; gold recovery saved in battery, 80 per cent; on plates, 20 per cent; percentage of sulphurets, 1½; value of sulphurets, $80 to $120 per ton; pressure of water used for power, 300 feet; quantity of water used, 280 miner's inches; number of men employed in mill and mine, 12; wages paid, $2 50 to $3 per day.

EVENING STAR.

Adjoining the Uncle Sam southerly is the Evening Star Gold Mine now in progress of development, with an adit level of one hundred and sixty-one feet, two hundred feet of lateral drifts, and one hundred feet of backs. Large ledge, but low grade ore. This mine is said to have produced richly in former times, but the ore body became exhausted, and prospecting for another "kidney" is now going on. There is a mill on the property with four seven-hundred pound stamps, run by water power.

KLAMATH GOLD MINE.

Next comes this once celebrated mine, embracing four thousand four hundred feet of lode line, with its miles of levels, drifts, and winzes, gravity trams, buildings, etc., altogether a most expensive plant. This mine is said to have yielded $500,000. The elevation of the principal works is four thousand five hundred and fifteen feet above the level of the sea. To offset the sum extracted, a large amount of money was expended in the development of this property, which was finally sold to the Gold Ball Mining Company of Canton, Ohio, for a small sum.

MISTLETOE QUARTZ MINE.

There are adverse claims to this property. While Messrs. Golden & Enlith are in possession, their right is disputed by the present owners of the Klamath Mine. The Mistletoe has the usual extent of ground, one thousand five hundred by six hundred feet, with a course east and west, and dipping 30 degrees southerly. It has been developed for thirty feet in depth by an inclined winze, and shows, on the croppings, a shoot of ore one hundred and sixty feet in length. The formation is in black slate.

BLACK BEAR.

Crossing the Blue Ridge Divide at an elevation of four thousand three hundred and sixty feet above the level of the sea, the adit level and hoisting plant

of the Black Bear Quartz Mine are reached. This mine has yielded heavily and contributed largely to the prosperity of the county. The ore bodies occurred in "kidney" and lenticular-shaped deposits—similar to those of the so called bonanzas of the Comstock, Nevada, and the Keystone, as well as other mines on the mother lode in Amador County—and this fact was so little understood by the owners that as soon as one of these "kidneys" was worked out, or showed signs of failing, they sold the mine at a nominal figure. A change in the management led to the discovery of other ore bodies; and as the property is now one of the live quartz mines of the Pacific Coast, a portion of its history is worth reciting. The Black Bear was discovered in 1860, and the ores were worked in arrastras from that time till 1861. In 1862 a twelve-stamp mill was erected at a very heavy expense, owing to the cost of transporting the machinery on mule-back over long, difficult mountain trails. The mine was worked till 1865, when the first discovered ore body became exhausted, after yielding the gross amount of $65,000, with, however, a loss of $40,000 to the owners. Feeling discouraged, they sold the property to Lieutenant-Governor Daggett and his associates, who proceeded vigorously in the work of further development. Another ore body was soon struck, the yield of which (as per company's books) from 1866 to 1872 was $405,691 67. Of this sum $225,802 38 were paid in dividends. While in bonanza, the property was sold to Messrs. Thomas Bell and Cross & Co., of San Francisco, who acted for an English syndicate. The bullion account of this mine is as follows: Gross yield from 1872 to 1886, $1,933,745 50; dividends declared, $616,500.

The ore body again showing evidences of weakness the English company worked the mine for what was in sight, and when, as they supposed, it was exhausted, resold it to the previous owner, Governor Daggett, who proceeded to reopen and extend the workings. Since his purchase the mine has yielded $63,844 78—the larger portion of which has been expended in dead work, and in the construction of a gravity tramway from mine to mill, a distance of two miles, which will enable a delivery of ores to be made at a nominal expense.

The mine is at present on a paying basis, with evidences of having reached the apex of another ore body. The ores now being worked at the mill are paying from $10 to $12 per ton without selection, with some very rich black quartz in sight showing gold freely. The mine is situated at the head of Black Bear Gulch, Sec. 13, T. 39 N., R. 12 W., M. D. M. It contains five thousand two hundred linear feet of lode, with a course north 20 degrees east. The Black Bear is worked through an adit level nine hundred feet in length, a crosscut reaching the vein at that distance with one thousand two hundred feet of lateral drifts on the vein. A winze has been sunk from the vein to a further depth of six hundred feet, which gives a height, vertically, to the surface of eight hundred feet. There are two well defined ore channels, or veins, known respectively as the Black Bear and the Yellow Jacket, separated by a gray compact slate. The water season lasts about eight months; steam is used for the remainder of the year.

Summary.—Length of ore shoot, variable, say from 50 to 100 feet; powder used, 12 boxes Nos. 1 and 2 Hercules during the year; cost of mining ($1 50) and milling ($1 25), $2 75; cost of tunnel per foot, $1 50 to $1 75; cost of shaft per foot, $3—all timbered with fir, at 4 cents per running foot; road, 3 miles; flumes, 2 miles; cost to transport ore, 40 cents per ton; ore, friable quartz, free milling; works, stamp mill, plate amalgamation; number of stamps, 32; weight, 650; drop, 6 to 9 inches; drops per minute, 80; tons crushed in 24 hours by each stamp, 1¼; white iron shoes and dies; screens, angle-slot punched, No. 7; water used in battery, 2 inches to each; apron, 4 by 6 feet; length of sluice, 6 feet; feed, percussion (old style); percentage of gold recovery saved in battery, 80; on plates, 20; percentage of sulphurets, 1½; value, $80 per ton; number of men in mill, 3; mine, 12; outside, 5; average

wages in mine, $30 per month; in mill, $45 to $50 per month; outside wages, $1 per day foreman, $75 per month; teamster, $40; blacksmith, $30; cook, $25, board included.

THE MYSTERY.

This mine is one thousand feet westerly from the Black Bear ledge. The vein is from two to four feet wide, and is opened by two levels (one hundred and eighty feet) and a shaft sixty feet deep. Some stoping has been done, and the quartz extracted (sixty tons) paid about $25 per ton in the mill. Formation, serpentine.

VOLUNTEER AND RISING SUN.

Proceeding down Black Bear Creek six miles, to its junction with the South Fork of the Salmon, at a point opposite Yocumville, on Methodist Creek, a number of small veins are found in course of development. The country rock is metamorphic slate. The Volunteer, formerly known as the Indian Queen, is driving an adit level two hundred feet long to connect with a shaft sixty feet in depth. The vein is from two to four feet wide. The Rising Sun has a one-stamp mill for prospecting a number of claims in the vicinity.

THE KNOWNOTHING.

The next creek below is called by this name, and on it discoveries of gold-bearing quartz have recently been made, inducing quite a number of miners to visit the locality. The Knownothing Mining Company is building an eight-stamp mill. They also own the Wolverine and a number of small ledges in the vicinity.

THE QUIMBY.

Here is a twelve-inch vein, one hundred and seventy-five feet of tunnel, and sixty-five feet of shaft. The vein is traceable on the surface for seven hundred feet. Rock reported to pay $10 per ton.

THE HANSON MINE.

A twelve-inch vein, two hundred and eighty feet of a drift, and sixty feet of a shaft. The ores are worked in an arrastra, and, as reported, pay from $30 to $45 per ton.

THE GILTA, AND OTHERS.

The above are on the opposite side of the creek. The Gilta has an eight-inch vein of rich rock, and a four-stamp mill driven by water power from Middle Creek. The Gold, Gilta, Hunter, and Jeannette are said to be prospecting well.

SCOTT BAR MILL AND MINING COMPANY.

Returning to Scott Bar from this point, we find the property above named, consisting of twenty-four acres by location and thirty-seven and one half acres held under United States patent. The mine is situated on Quartz Hill, in the vicinity of the town, and in the Scott River Mining District. The formation is micaceous and talcose schist with quartz; course northeast and southwest, dipping easterly. In this formation is found a series of parallel veins, five or more. The most southerly of the series is

now being opened by a shaft, which has reached a depth of sixty feet. There is but little water in the mine, a four-inch jackhead pump being sufficient to keep it free. The drills in use are seven-eighths octagon steel. the powder Hercules No. 1, of which twenty-five pounds per day are consumed. Mining the ore costs about 75 cents per ton. The shaft costs $10 per foot to sink, and the tunnel is driven for $4 per foot. Ores from the shaft are landed in the mill by means of a tramway two hundred feet long. In places, the ore is friable and crystalline; fineness of gold, 845. The ores are reduced by stamp and amalgamation on copper plates. Size of mill building, thirty-two by sixty feet, containing ten stamps with self-feeders, the weight of each stamp being seven hundred and fifty pounds, with a drop of six to nine inches eighty times to the minute. The shoes and dies are of white iron, costing 6½ cents per pound delivered; a set will last forty days. Each stamp crushes two tons per day, through a No. 8 slot punched screen. Two miner's inches of water are used.

The length of each sluice is twenty-two feet, with a width of four feet, and are lined with silvered copper plates, with a grade of one inch to the foot. About 75 per cent of the gold recovered is saved in the battery, and 25 per cent on the plates; the loss of quicksilver is light. The ore contains one half of 1 per cent of sulphurets, consisting of iron, zinc, antimony, and tellurides; value per ton, from $80 to $1,000. Four men are employed in the mill, and eight in the mine, with two helpers and a Superintendent; in all, fifteen. Average wages of miners, $2 50; of mill men, $3 25; outside hands, $2. Seventy-five inches of water under pressure of two hundred and twenty-six feet are used for power, by means of a four-foot Pelton wheel. The carrying capacity of the ditches is as follows: Ditch from Mill Creek, three hundred inches; Shirer Creek, one hundred inches; Hyde Creek, eight hundred inches; total, one thousand two hundred inches; furnishing at the mill and mine the following head: Hyde Creek, three hundred and twenty-five feet pressure head; Mill Creek, two hundred and ten feet pressure head.

The mine had, for many years, been worked by former owners as a hydraulic claim, with good results, and the present company still have two No. 2 Hydraulic Giants in constant use. The gold thus set free is caught in sluices, the quartz taken to the mill and crushed. There are four hundred feet of sluices, thirty-six by twenty inches in size, with iron riffles. This company now propose to sink the shaft two hundred feet deeper, drive lateral drifts every one hundred feet, and so crosscut the whole series of veins, and, at the same time, to enlarge their milling capacity by the addition of forty stamps.

PARALLEL VEINS.

On the west side of the river, one half a mile on the line of and below the ditch that belongs to the Scott River Hydraulic Mining Company, a large vein of low grade quartz may be noticed, now being developed, with quite a number of small parallel veins lying adjacent. The latter carry high grade ore; these have been developed by drifts. The ore extracted has been worked in arrastras, the yield being, it is said, from $25 to $30 per ton.

ENTERPRISE DRIFT CLAIM.

This property lies northerly from Scott Bar, and is opened from the river by a one thousand-foot tunnel, extending into an old river channel which carries cemented gravel on the bedrock, with a stated yield of from $100 to $150 to the square set of timbers. The channel, from rim to rim,

is four hundred feet wide, and the gravel extracted is first burned in a pit or heap, and then crushed in an arrastra—a tedious process; a cement mill would be a great improvement.

THE CASSEL QUARTZ COMPANY.

Leaving Scott Bar on the east side of the river, coursing easterly, and following Mill Creek four miles, to a point near the summit of Scott Range of mountains, and distant three miles from the head of McKinney Creek, a well defined vein of quartz will be found, the croppings of which encircle a mountain peak, seemingly dipping to a common center. The ores from this vein are reported to be very rich, carrying a large percentage of sulphurets. There are two locations on the line of croppings. That of the Cassel Quartz Company embraces one thousand five hundred by six hundred feet, and the ledge varies in width from eight to thirty-six inches. It is opened by adit levels. Specimen pieces of the ore pounded in a mortar have yielded, according to the owner's statements, at the rate of over $10,000 per ton.

LAST CHANCE MINE.

This property is located at the head of Indian Creek, a tributary to Scott River, in the Indian Creek Quartz Mining District, at an elevation of four thousand seven hundred and ten feet above the level of the sea. The location measures one thousand five hundred by six hundred feet, and is developed by a four hundred-foot cross-cut through country rock to vein, the trend of which is north and south, width from fifteen to twenty inches, dipping east at an angle of 60 degrees. A lateral drift on the vein reaches a cross vein running east and west, and dipping north 45 degrees, well defined, and averaging twenty inches in width, the ore friable and free milling. Of this ore, two hundred and fifty tons were extracted and treated in the company's five-stamp mill, yielding, according to owners' statement, $50 per ton. The stamps weigh seven hundred pounds each; the motive power used is both steam and water, the former being resorted to when the latter fails, which it does about six months of the year.

THE MILLER & HITE QUARTZ MINE.

This mine (one thousand five hundred by six hundred feet) is located at a point one thousand two hundred feet from the Last Chance. It is reported to have paid well until the mill burned down. Work is suspended for the present.

THE BAILEY QUARTZ MINE.

Two thousand feet from the Miller & Hite Mine is the Bailey. The vein averages from eighteen inches to two feet in width, at times expanding to five feet. The property is one thousand five hundred by six hundred feet, and is opened by an adit level. The mine is in progress of development.

BONANZA QUARTZ MINE.

This location on Grizzly Gulch measures one thousand five hundred by six hundred feet; course, northeast and southwest. The formation is porphyry and slate; vein from six to eighteen inches in width; ores reported to pay from $6 to $100 per ton. The mine is developed by adit level, giving four hundred feet of backs. Two thousand tons have been worked

from a pay shoot sixty feet long, and yielded, as per Superintendent's statement, from $100 to $200 per ton. There is but little water flowing from the tunnel, and the mine has no deeper workings than those afforded by means of the adit.

THE GOLDEN EAGLE.

The central point of this quartz mining section is the town of Hooperville, lying two thousand feet or more from the Bonanza. In the immediate vicinity of the town, the Golden Eagle Mine is being worked. This mine is better known as the Indian Creek Mine. The course of the vein is northerly and southerly, with westerly dip, width from eighteen to thirty-six inches. The ore is said to have a value of $14 per ton. This mine was developed by a tunnel driven on the vein four hundred feet, in ore the entire distance. From tunnel level to surface the vein has been all "stoped out."

SEVEN–THIRTY QUARTZ MINE.

This is a location next to the one just above mentioned, measuring one thousand five hundred by six hundred feet, and in process of development.

THE GOLDEN EAGLE MINE.

This (the second of this name) controls three parallel veins from eighty to one hundred feet apart, varying in width from eight to eighteen inches. The property measures one thousand five hundred by six hundred feet, and is being vigorously developed.

BAKER QUARTZ MINE.

The claim is one thousand five hundred by six hundred feet, and lies one thousand eight hundred feet west of the Seven-Thirty, and has a vein eighteen by twenty-four inches wide, with a course east and west.

THE OCHRE LEAD QUARTZ MINE.

This property adjoins the above, and has the same measurement, with a vein from eighteen to twenty inches wide, developed by an adit level two hundred and fifty feet in length. The ore is said to yield $25 per ton. There is a ten-stamp custom mill in the vicinity.

WALTER SQUIREM QUARTZ MINE.

This mine, one thousand two hundred feet west and parallel to the last named, has a vein from three to eight feet in width, developed by adit level and shaft. Test crushings of ore reported to have yielded $20 per ton.

[All the mines mentioned above, on Indian Creek and tributaries, are within a radius of two miles from Hooperville, and comprise a group of small veins. The only obstacle to proper development seems to be a want of adequate milling facilities.]

HOOPER LOWER QUARTZ CUSTOM MILL.

This mill contains five stamps of five hundred pounds each, with self-feeders. The mortar has inside copper plates. The screens are No. 9 punched slot. The apron is thirty-nine inches wide by fifty inches long;

the sluices, twenty feet long, are divided into a series of steps twenty-six inches long, with one-inch grade and four inches drop to each. Motive power is obtained from a thirty-foot overshot wheel, supplied with one hundred inches of water from Indian Creek. Season lasts from six to eight months in the year. The foreman of this mill stated that the ores of the district carry about 2 per cent of sulphurets, which average $250 per ton: but no attempts have yet been made to utilize them.

JOHNSON QUARTZ MINE.

Westerly four miles from this point, and crossing Scott River, Oro Fino Valley is entered. This valley is divided from Quartz Valley by a low divide, the formation of which is talcose slates, through which run dikes of porphyry and trap, with veins of quartz. As a rule, these veins are pockety. The principal mine on the divide is the Johnson, containing fifteen hundred by six hundred feet of ground, under United States patent. It is situated on the Oro Fino side. This mine was opened in 1874, and has been worked in a desultory manner up to the present time. Notwithstanding irregularity in this respect, however, the mine has paid all the expenses of its development, and has returned a profit stated by the owner to be $73,011, from a gross yield of $158,011 21. The vein varies in width from a few inches to three feet. Its course is north and south, with an easterly dip of 40 degrees, and is opened by two drifts, one two hundred and fifty feet, the other three hundred feet in length. A still lower depth (four hundred feet from surface) can be reached by tunnels. This property owns a ten-stamp mill, run by water power, and the ores crushed, according to the Secretary's books, have paid from $17 25 to $50 10 per ton. Owing to the death of the owner, the mine is idle at present.

VALUATION QUARTZ MINE.

This property lies on the eastern slope of the Oro Fino Divide, and is developed by three tunnels. The lower or adit level is eight hundred feet long, with two hundred feet of backs; the second level above, one hundred feet long; the third, forty feet. The vein averages twelve inches in width, and is said to pay from $15 to $100 per ton. It is worked in arrastras. The receipts the past eight years, as stated, were $40,000.

DUFF QUARTZ MINE.

The vein ranges from eight to ten inches in width. Drifts are in two hundred feet; yield said to be $10,000 to date.

THE "C," GALENA, SARGENT.

This and a number of smaller veins, worked by the owners in a small way, pay wages. As a rule, the mines in this range are pockety, and cannot be relied on for regular yields.

SCHROEDER AND WARNER.

This quartz property is located on the headwaters of McAdams Creek, in the Deadwood Mining District, and has five thousand seven hundred and twenty linear feet, in the aggregate, of vein locations. There are five parallel veins—the Peerless, Vivian, Rosalie, Blue Ledge, Mountain Boy,

and an extension of the latter, called Solid Metal. The Mountain Boy, Vivian, and Peerless have been developed, as follows:

Name.	Length of Adit Level.	Width of Vein.	Length of Ore Shoot.
Mountain Boy	No. 1, 125 feet.	4 feet.	120 feet.
Vivian	No. 1, 500 feet.	2 feet.	500 feet.
Peerless	No. 2, 300 feet.	18 inches.	60 feet.
Peerless	No. 1, 200 feet.		
Totals	1,125 feet.		680 feet.

The vertical depths reached from surface are as follows: Mountain Boy, one hundred feet; Vivian, two hundred feet; Peerless, one hundred feet. There is not much water in the mine. The formation is soft and yields readily to the pick, and but little powder is used. Wherever needed, the single hand drill and Giant explosive is used in the place of large drills and black powder. Drifts are run at a cost of $4 per foot. On account of the ground being soft the mine requires to be well timbered, a plentiful supply of which is at hand on the mountain sides. The veins are faulty and "thrown." Three miles of road have been made by the company. A double incline tramway at a grade of 28 degrees and one thousand feet in length transports the ores from the mine to the mill. Ores are treated by ordinary amalgamation in a battery of five stamps. Steam is the motive power. The stamps weigh eight hundred pounds each, and drop eighty-two times per minute; steel shoes and dies are used, costing 9.3 cents per pound. They wear sixty days and crush six hundred tons of ore. One and a half miner's inches of water are used in the battery. The discharge is through a No. 11 slot-punched screen; the aprons are four by six feet, and the width of the sluices sixteen inches, with a length of sixteen feet; both aprons and sluices are lined with silvered copper plates, set at an inclination of one inch in twelve feet. The roller feeder is used for the battery; the mortars are twelve by fifty inches. The sulphurets are concentrated by a Frue vanner. The percentage of gold recovered in the battery is nine tenths of the whole, while one tenth is saved on the outside. The concentrator requires two inches of water. The ore carries 2 per cent of sulphurets, assaying $80 per ton; those of the Mountain Boy are arsenical. The company having no method for properly treating these rebellious ores, are not working this portion of the mine at present.

The Vivian has three raises on the five hundred-foot level, and two on the second, each of ninety feet, and one of two hundred feet on the third; the latter has been stoped to the surface. Sixteen hundred tons of ore have been extracted and milled, which (taking the owner's statement), yielded $27 59 per ton. The ore being worked at present is paying, according to report, only $12 per ton.

The company propose this year to extend the levels and put up additional stamps.

COMSTOCK No. 2 QUARTZ MINE.

Crossing the Deadwood Divide, northerly two miles, at the head of Sucker Creek, a tributary to the North Fork of Humbug Creek, we arrive at Comstock No. 2, in the Humbug Quartz Mining District. The location, one thousand five hundred by six hundred feet, was made in 1875. This mine is distant from Yreka fifteen miles by road, and ten miles in an air line. The strike of the vein is northerly and southerly, dipping easterly

65 degrees. It averages two feet in width, and is opened by three tunnels, the aggregate length of which is seven hundred and thirty-five feet, and respective length, as follows: No. 1, one hundred and seventy-five; No. 2, three hundred, and No. 3 (the adit), two hundred and sixty feet. As the ground is broken and heavy, the levels are all timbered closely. There are two ore shoots on the mine, one of seventy and the other of two hundred and seventy feet in length. The hanging-wall is porphyry and foot-wall dioritic trap. Vein matter is friable, broken, and decomposed; requires but little powder. The small quantity of explosive used is Giant No. 1. There is one mile of road built by the company and four hundred feet of ditch. Ores are transported to the mill, on a sled drawn by horses, a distance of about one thousand feet, and costs 40 cents per ton for hauling. The mill is a substantial frame building eighteen by thirty-six feet, with five stamps, white iron shoes and dies, costing 8 cent per pound delivered at the mine. A set lasts ninety days.

The stamps weigh four hundred pounds each and drop from four to six inches, crushing in twenty-four hours six tons; one inch and a half of water are required in battery; a slot-punched No. 9 screen is used; the aprons are three feet wide and six feet long. From the apron, the pulp discharges on a rocker concentrator, covered by five by three feet of prepared copper plates, set at an inclination of one inch and a half to the foot. The battery is fed by a percussion feeder of the proprietor's own invention. Seventy per cent of the gold recovered is saved in the battery, and on the apron, 20 per cent, with 10 per cent on the concentrators; the loss of quicksilver in use is slight. The ores contain 8 per cent of sulphurets, assaying $66 per ton. The concentrations are oxidized by exposure to the atmosphere, and are re-fed with the ores in the mill. About one cord of pine wood is consumed for steam purposes, at a cost of $1 25 per cord. Three men are employed in the mine, at $2 50 per day; and in the mill, two, at $3. On the outside, two hands are paid $40 per month with board. The mill is run by a ten-horse power engine. During the past year extensive exploiting has been done, it being the intention of the owners to develop minerals sufficient to supply a larger mill.

ABANDONED VEINS.

In the vicinity of the last described mine, and north of the Deadwood Mountain Range, on the headwaters of the South and Middle Forks of Humbug Creek, may be found an area of about eighteen square miles, in which occurs a formation of metamorphic slates with intrusive dikes of traps and porphyries, inclosing groups of auriferous veins, their general trend being northerly and southerly. Quite a number of these veins have been successfully worked to a depth of several hundred feet, or so far as the line of disintegrated quartz extended; but when that point was reached the mines were abandoned. The ores found below the disintegrated quartz of these veins are, as a rule, base, containing arsenic, lead, and zinc. Recent discovery on the headwaters of the South Fork of the North Fork of Humbug Creek, of a mine called the Standard, said to carry a strong vein of high grade ore, is creating a little stir in this region.

THE LUNA MINE.

On the South Fork of Humbug Creek, six miles distant from the abandoned area just described, is a location, with the above name, made January 1, 1888. It is in the Humbug Mining District, and six miles northeast from Yreka. The course of the lode or vein is northwest and southeast,

Blue Gr
Herzan
McConn
Humbu
Lime G
Centenn
Empire
Napa B
Filmore
Klamath
Pine Gr
Buckeye
Kohl Ba
Poverty
Sambo
John Ch
China S
Hong K
Canton
Frank T
Singleton
Grider
London
China W
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with a northerly dip of 60 degrees. The average width of this vein is two and one half feet, with two hundred and thirty-five feet of a well defined shoot of ore. The location has been opened by two tunnels, one, two hundred and thirty-five feet long, and the other, one hundred and twenty feet, with a vertical height, at end, to surface of one hundred feet. Hanging-wall, porphyry; foot-wall, slate. The vein matter is easily mined, and powder is not required. Ore is taken out for 25 cents per ton. Levels can be driven for $1 25 per foot, at the rate of four feet per day. The work is all closely timbered, as the ground is heavy, decomposed, and broken. Fir and pitch pine are used for timbering, and cost 10 cents a set, wood being abundant in the vicinity. The company has made two miles of road, and three quarters of a mile of ditch. Ore is hauled in wagons to the mill, at a cost of $1 25 per ton. The ore is free milling.

The mill contains four stamps weighing five hundred and fifty pounds each, dropping at a speed of sixty times per minute, and crushing three quarters of a ton of ore to the stamp in twenty-four hours. White iron is used for shoes and dies, costing at the mine 10 cents per pound. Two inches of water are used in the battery, and the pulp is discharged through a No. 7 slot-punched three by six screen, on to silvered copper plates. The sluices are twelve feet long, with two compartments, six inches wide, each lined with copper, and set at a grade of one inch to twelve feet. The battery is supplied by a patent feeder. About 80 per cent of the gold recovery, mostly coarse, is saved in the battery and 20 per cent on the outside plates. Blankets are used as concentrators, and the concentrations, after oxidation, are worked over in the mill. Four hands are employed in the mine and two in the mill; one outside. Miners receive $1 50 per day and board; mill men, $3; outside hands, $1. The mill is run by water power (supplied free) on an overshot wheel thirty feet in diameter. The proposed improvements on this property are to drive an adit level and a tunnel three hundred feet lower down; to erect a new mill near the mine, where sufficient water can be obtained all the year. The ore is reported to pay $9 to $22 60 per ton.

MISCELLANEOUS.

There are large areas of auriferous ground in this county that have not been prospected, except by the hunter, packer, and Indian. As an illustration, it may be mentioned that, recently, on the headwaters of Hungry Creek, a tributary to the Beaver, which in turn flows into the Klamath, a long line of bold croppings were observed by a traveler, who broke off a sample, and on testing it with a horn, found the rock rich in free gold. The location is now being developed by shafts and drifts. The vein is three feet wide between walls of porphyry and syenite. Average value, stated to be about $30 per ton.

BARKHOUSE CREEK.

This creek is a tributary to the Klamath; three and one half miles from its mouth, ore is being worked in an arrastra from a shaft sixty feet deep on a vein from one to four feet wide. Average value is said to be $60 to $80 per ton.

CALLAHAN'S RANCH.

Two miles distant on Scott River, on the above ranch, is the Crowley Mine, having an ore body twenty-five feet in width. The gangue is porphyritic, carrying $6 per ton in gold. Water for power is abundant within six

hundred feet of the mine. The trend of vein is north and south, and the ore shoot is estimated to be five hundred feet long.

GREENHORN GULCH.

In this gulch, a tributary to Yreka Creek, quite a number of quartz locations are being prospected, and more or less developed. The veins are, as a rule, small.

THE CAPE MINE.

At the head of Hungry Creek, also a tributary to Yreka Creek, three miles from the county seat, the Cape Mine, one thousand five hundred by six hundred feet, is located. It is being developed by two shafts, each seventy feet deep and sixty feet apart. The dip of the ledge is 70 degrees south and courses west 20 degrees north. The vein is from two to three feet wide. The ore from this mine is now being worked in a custom mill near Yreka.

THE COLLATERAL.

In the vicinity of Yreka, at Humbug Gulch, due west from the county seat one mile, is the Collateral, one thousand five hundred by six hundred feet, and with its vein developed by a two hundred and twenty-eight-foot tunnel; it has also winzes and raises. The vein lies between walls of slate, and is ten inches wide. Four men are employed. Eighty tons of ore crushed are said to have yielded $34 20 per ton; fineness of gold, 811.

THE DARLING LEDGE.

This ledge is situated in Rocky Gulch, a tributary to Cottonwood Creek, half a mile distant from the Collateral.

THE CALIFORNIA QUEEN.

The course of the ledge is northeast and southwest, dipping east 45 degrees, and is opened by a tunnel forty feet long. The vein is two feet wide. Fifteen hundred tons of ore crushed returned $30,000. The mine at present is idle for want of water. There is a five-stamp mill on the property. Stamps weighing five hundred and fifty pounds each drop six to seven inches eighty times per minute. Copper plates are used inside of the battery; there are two aprons—one, five by four feet, and one, six by four feet. Sluices, twelve feet long, are supplied with riffles and blankets. Battery has self-feeders. Motive power, an overshot water wheel, thirty feet in diameter.

RECAPITULATION.

The data in the general tabular statement accompanying this report show the following claims in operation whenever conditions are fitting, particularly the supply of water, on which this interest is entirely dependent: Hydraulic claims, forty-seven; wing dams, twenty-two; drift claims, twenty-three; sluicing claims, seven; employing nine hundred and forty-two operatives. This is an underestimate of the actual number of men employed in the mines of Siskiyou County. A large number of men are engaged in prospecting and opening claims who have not been taken into account.

The quartz interest of the county is yet in an embryo state. Compara-

tively, little attention is paid to it. It is beginning to assert itself, however, as will be seen by the tabular statement already referred to. There are now sixteen mills in operation, dropping one hundred and twenty stamps. As in the case of gravel, the output of gold from the various mills is extremely difficult to arrive at. The number of men employed is about one hundred and twenty—or one man to a stamp. This would swell the number directly engaged in mining in this county to one thousand and sixty-two.

SOLANO COUNTY.

This county is named after Solano, formerly a chief of the Suisun tribe of Indians, though the same word in the Spanish language means the east wind. Solano is bounded on the north by Yolo, on the east by Yolo and Sacramento, on the south by Contra Costa, Suisun Bay and the Straits of Carquinez being the division line, and on the west by Napa County.

The eastern third of this county is quite level, more than one hundred thousand acres being composed of tule lands. The central portion has an undulating surface, while the western breaks into high rounded hills, which constitute a portion of the eastern slope of the Coast Range. The soil is everywhere rich, this, taken as a whole, being one of the most fertile and productive counties in the State. Solano contains but few streams of any magnitude. Cache Slough traverses it near the center, flowing southeast, Mill Creek in the western part flows south, the Sacramento River forming the county boundary on the east. This is one of the most sparsely wooded counties in the State, the only timber native to the soil consisting of a much scattered growth of white oak, confined chiefly to its northwestern part. The few cottonwoods that formerly grew along the streams are now all cut away.

METALS AND MINERALS.

Solano, so far as known, contains no deposits of the precious metals, though several of the economic metals and minerals occur in the county, some of them quite abundantly.

CINNABAR.

In the hills about six miles east of Vallejo, a number of veins carrying the sulphuret of mercury were discovered many years ago, this being the site of the St. Johns and the John Brownlie Mines. At the former, which was afterwards opened somewhat and equipped with plant, a small production of quicksilver was made, though nothing has been done there for the past ten years. None of the other veins in that locality have been much developed.

MARBLE, BUILDING STONES.

Marbles of different kinds, some of them of rare beauty, are found in this county. In the hills near Suisun Valley is found a marble which, in the rough, bears a strong resemblance to resin. Being fine-grained and compact, it takes on a high polish, and is much esteemed for ornamental purposes. Located about four miles north of Fairfield, the county seat, is a bed of aragonite, popularly called onyx, and fully described by the State Mineralogist in the report of the year 1884. Stones suitable for structural purposes are met with in many parts of Solano, a good deal of serpentine and sandstone being quarried in the neighborhood of Benicia. Clay adapted

for brick making is also plentiful. There is a deposit of chrome iron near the town of Fairfield, but, as yet, little or nothing has been done with it. In the hills adjacent to Benicia, also on the margin of San Pablo Bay, and not far from the town of Vallejo, there exists a fair quantity of hydraulic limestone; the last mentioned deposit being submerged at high tide. The Benicia deposit was for a time worked quite extensively, an establishment having been put up for burning and grinding the material. Although a tolerably good cement was made here, the enterprise, owing to various causes, was abandoned.

SONOMA COUNTY.

Sonoma is an Indian word signifying, in that language, "Valley of the Moon." This county is bounded on the north by Mendocino County, on the northeast and east by Lake and Napa Counties, on the south by the Bay of San Pablo and Marin County, and on the west by the Pacific Ocean. Sonoma is traversed in a northerly and southerly direction by the several high ranges that here form a part of the main Coast Range. While these ridges have a common elevation of less than two thousand feet, there are a number of peaks standing in them that reach a much greater elevation. Between these ridges are the large, beautiful, and fertile valleys of Sonoma, Petaluma, Santa Rosa, and Russian River. The central and northern parts of this county are well watered by Russian River and its numerous tributaries, Sonoma and Petaluma Creeks flowing through the southern part and emptying into San Pablo Bay. The mountains on the west side of the county are well timbered with redwood and pine, those further east being covered with a scattered growth of scrub pine, oak, and madrona. White oaks, many of them of large size, are also found in the valleys.

MINERALS AND METALS.

Although Sonoma is among the foremost vine and grain-growing counties of the State, its mineral wealth is by no means inconsiderable, both the royal and several of the more common metals being counted among this class of its resources. The gold deposits here consist mainly of auriferous sands on the ocean beach, and some placers of limited extent along the confluents of Russian River. In excavating near Tyrone, on the line of the North Pacific Railroad, some small stringers of silver-bearing ore, associated with magnesian shales, have been cut. Argentiferous indications are reported elsewhere in the county. One and a half miles east of the same locality is situated the Sonoma Copper Mine.

The ore here, of which there are some fifty tons on the dump, consists mainly of sulphurets, with some carbonates. The water that seeps from the mine is so highly charged with sulphate of copper that any bright iron article immersed in it becomes speedily coated with metallic copper. Chrome iron has been found at a point about four miles north of Guerneville, also near Lytton Springs, in the vicinity of the Geysers, and on the Truett Ranch, near Asti. Manganese ore, pyrolusite, occurs near Santa Rosa; also near Guerneville and in the coal mine on Mark West Creek.

QUICKSILVER.

Deposits of cinnabar occur in this county at the following localities: Near the Geysers, at Livermore Flat, at the junction of Pluton and Sulphur Creeks, in Pine Flat, and in Guerneville.

THE GREAT EASTERN MINE.

This, the only quicksilver mine now being worked in Sonoma County, lies four miles north of Guerneville, with which place it is connected by a wagon road of easy grade. Besides their own claim, the company are working the Mount Jackson, adjoining it, having the property under lease; these claims cover one thousand five hundred by six hundred feet each. The course of the vein here varies from southeast to northwest to east and west; its dip being at an angle of about 80 degrees.

The ore, cinnabar, mixed with a peculiar siliceous rock and jasper, occurs in shoots often one hundred feet long, and from ten to twenty feet wide. The foot-wall of the vein is serpentine and the upper sandstone; the vein sometimes leaving the sandstone and cutting directly through the serpentine.

The mine is opened by a vertical shaft, in the foot-wall, three hundred and sixty-five feet deep. From the bottom level a winze has been put down forty feet, making the entire vertical depth prospected four hundred and five feet. The ore is mined by back stopes from the different levels. To free the mine from water a No. 5 steam pump is kept running steadily. The Burleigh drill and compressor are in use here. The ore is delivered at the reduction works by an automatic inclined plane. Two McDonald furnaces for the coarse ore, and one Ames furnace for the fine ore, constitute the plant.

At present fifteen tons of ore are being reduced per day of twenty-four hours, ten men in the mines, four in the reduction works, and ten on the outside being employed. Wages of white men, $1 50 to $2 50 per day, with board; Chinamen, $1 50 per day, the latter boarding themselves.

LIMESTONE.

On Little Sulphur Creek, four miles east of Geyserville, occurs a deposit of limestone in the shape of enormous bowlders, some of which stand seventy-five feet above the surface. A kiln has been erected here, about one thousand barrels of lime being turned out per month. An analysis of this limestone, made by Thomas Price, gives the following result:

Carbonate of lime	95.20
Silica	1.27
Peroxide of iron and alumina	.43
Oxide of manganese	.18
Magnesia and loss	1.32
Water	1.60

At Mark West Springs occurs a bed of limestone measuring seventy-five feet in thickness.

IRON ORES.

Iron ores, principally in the form of the sesquioxide, are met with in various parts of Sonoma, some of them being suitable for the manufacture of mineral paint, especially that at Mark West Springs. Near the southern end of the railroad bridge over Russian River, at Duncans Mills, occurs a large deposit of ferruginous shale. Some mineral paint has been manufactured from the deposit of oxide of iron found about one mile south of Tyrone. There are also deposits of iron ore near Guerneville, at Ingrams, and near Santa Rosa. Sulphate of iron (melanterite) occurs as an incrustation at the Geysers.

COAL.

Lignite that makes a tolerably good fuel is found cropping out at many localities in this county. At a point two and a half miles southeast of Santa Rosa the Taylor Mountain Coal Mining Company has opened three seams of lignite, which vary from four to eight feet in thickness. These seams are underlain by sandstone, having as a hanging-wall fire clay and shales, with sandstone above them. John A. Hill has opened some excellent coal prospects on Mark West Creek. On Rule's Ranch, between the mouth of Russian River and Russian Gulch, a small seam of good lignite crops out.

MINERAL SPRINGS

The Mark West Springs lie on the south side of Mark West Creek, about nine miles northeast of Santa Rosa. The group consists of three springs, each containing sulphur, iron, and magnesia.

The water of the sulphur spring has a temperature of 92 degrees Fahrenheit; that of the other two being cold. What are known as the White Sulphur Springs are situated four miles from the town of Santa Rosa.

The Litton Springs,

Three in number, are located on the line of the San Francisco and North Pacific Railroad. These, by reason of the composition of their waters, which are bottled and exported, are also known as the Geyser Soda Springs, and sometimes as the Seltzer Springs. The analysis of these waters, made by Henry G. Hanks, shows them to contain the following, in grains, to the gallon:

Chlorine	78.32
Sulphuric acid	2.36
Carbonic acid	42.96
Silicic acid	2.92
Oxide of iron	2.85
Lime	4.41
Magnesia	5.24
Soda	62.19
Alumina, ammonia, potash, lithia, boracic acid, and organic matter	27.38
Total grains in gallon	228.63

On Hot Springs Creek, eight miles west of Geyserville, are located

Skaggs Springs,

Three in number, two being hot and one cold. An analysis of the water from the principal spring made by Professor Hilgard, gave the following grains to the gallon:

Chloride of potassium	.200
Sulphate of potassium	.260
Chloride of sodium	5.900
Iodide of sodium	Trace.
Bicarbonate of sodium	161.270
Biborate of sodium	26.470
Carbonate of lithium	.060
Carbonate of barium	.240
Carbonate of strontium	.024
Carbonate of calcium	2.197
Carbonate of magnesium	11.113
Carbonate of iron	.054
Alumina	.004
Silica	7.023
Total grains	214.815

The Geysers,

So called by way of distinction from other but less noted springs of this kind in the vicinity, are situated on Pluton Creek, sixteen miles east of Cloverdale.

Through the entire formation, some acres in extent, jets of hot water and steam are constantly escaping. It is stated that there has not been any analysis made of the waters, but from the vicinity of the various blow holes, melanterite, sulphur, alum, epsom salts, and cinnabar are found as incrustations.

PETRIFACTIONS.

About three miles northeast of Mark West Springs, covering an area of several acres, are found petrifactions of forest trees. In the vicinity of Santa Rosa similar fossils occur, but these, though generally small, are fine-grained and polish well, whereas the former are coarse-grained and not susceptible of a high polish.

BUILDING STONES.

At Freestone, on the line of the North Pacific Railroad, is found a bed of good sandstone. Near Petaluma, also in the vicinity of Laguna, a building stone is being quarried; that obtained at the latter place being fireproof. These deposits are being utilized for supplying building material in their respective neighborhoods. From one of the several basaltic dikes that traverse the easterly side of the county, large quantities of basalt are being quarried, and from the principal quarry in the vicinity of Santa Rosa, about twenty carloads—two hundred thousand blocks—are broken out and shipped weekly.

CLAYS.

The more common clays are plentiful in this county. Five miles above Guerneville, on the Russian River, the Santa Rosa Planing Mill and Brick Company manufacture annually one million bricks. They employ sixteen men and consume yearly four hundred cords of wood. The clay used in this yard is the sediment deposited in a bend of Russian River; the peculiarity of this bed is that as soon as it is exhausted the river is permitted to again flow over it, causing the bed to be renewed. The combination of the currents in the river at this point is evidently such that only the clays are deposited. At this point on the river T. B. Brown has opened a bed of potter's clay, which he utilizes for the manufacture of drain tile and flower pots. The plant consists of a P. H. Kells & Sons tile machine, run by a sixteen-horse power engine. The tiles are burned in a new style of kiln, and patented by Pike, Castle & Co. The capacity of these works is about four thousand feet of tile per day.

STANISLAUS COUNTY.

This county is named after the large river which forms in part the dividing line between it and San Joaquin County. The river itself was called the Stanislaus in honor of a christianized Indian chief, to whom that name had been previously given by the Catholic Fathers. It is bounded on the northwest by San Joaquin, on the northeast by Tuolumne and Calaveras, on the southeast by Merced, and on the west by Santa Clara County.

Three fourths of this county consists of an unbroken plain. A section on the east breaks into the lower foothills of the Sierra Nevada, a narrow strip on the west being covered by the eastern slope of the Coast Range, the summit of which forms the dividing line between this and Santa Clara County.

The only two streams of any size wholly within this county are the Tuolumne, flowing westerly, and the San Joaquin, flowing northerly across it. With the exception of a few oaks, mostly found along the river bottoms, and a scattered growth of scrubby pines on the eastern foothills, Stanislaus is without timber.

The soil throughout nearly all parts of this county is good, that along the rivers being extremely fertile. Large crops of the cereals are raised here; this, next to Colusa, which it nearly equals, being the largest wheat-growing county in the State. This is one of the few counties in California in which Indian corn can be successfully cultivated, thriving and yielding largely on the river bottoms. Fruit trees and the vine also do well here.

The principal towns in this county are Modesto, the county seat, Oakdale, present terminus of the Stockton and Visalia Railroad, Turlock, La Grange, Hills Ferry, Ceres, Salida, and Grangerville.

Stanislaus County cannot at the present day boast of any large store of mineral wealth. Formerly a good deal of gold dust was taken from the bars along the Stanislaus and Tuolumne Rivers, in the northeastern part of the county, but these bars have become so much depleted that they afford now employment to only a small number of men, and there being in the county, so far as known, no other deposits of the precious metals, the output of bullion has of late years amounted to comparatively little.

SUTTER COUNTY.

This county, named in honor of the distinguished pioneer, General John A. Sutter, is bounded on the north by Butte and Yuba Counties, on the east by Yuba and Placer, on the south by Sacramento, and on the west by Yolo and Colusa Counties.

This is a nearly level county, the only considerable elevation or even marked inequality of surface within its limits consisting of the Sutter Buttes, three peaks springing up from a short mountain range, described in remarks on Butte County. Occupying the delta formed by the Sacramento and Feather Rivers, the soil throughout nearly the whole of Sutter County is composed of a deep, rich alluvium, capable of producing bountiful crops of all kinds with a minimum of labor. For its size, Sutter turns out a larger amount of the cereals than any other county in the State. In the western part of the county, bordering on the Sacramento River, is a large extent of tule land, very little of which has yet been reclaimed.

The only large stream in this county is the Feather River, flowing across its southern end, the Sacramento forming the dividing line between this and the counties that bound it on the west. Sutter is without timber other than a narrow belt of sycamore and cottonwood along the rivers, with a few scattered oaks elsewhere.

The principal towns in this county, there being none of large size, consist of Yuba City, the county seat, Nicolaus, Vernon, Meridian, West Butte, and South Butte.

Although no metalliferous deposits of value have been found in Sutter, it possesses good building stones, with clay suitable for making bricks, and

during the early part of the present year a vein of coal two feet in thickness is reported to have been found near Sutter City, a town recently laid out in the western part of the county. This coal is of the cannel variety, and is said to be well adapted for the forge. Should this deposit prove to be permanent, and the coal be of the kind represented, the discovery, while it improves the status of Sutter as a mining county, will prove of great benefit to that section of the State.

TEHAMA COUNTY.

This county, named after an Indian tribe formerly occupying the valley of the upper Sacramento, is bounded on the north by Shasta, on the east by Plumas, on the southeast and south by Butte and Colusa, and on the west by Mendocino and Trinity Counties.

This county presents a great plain, a section of the Sacramento Valley occupying its middle portion, with the Sierra Nevada Mountains on the east and the Coast Range on the west. While the Sierra is heavily timbered with pine, spruce, and cedar, the Coast Range contains only a sparse growth of scrubby oak and pine, the sycamore and cottonwood that formerly grew along the streams being now about all cut away. Tehama is well watered. The Sacramento River flows south centrally across it, having for tributaries many large creeks, of these the principal streams coming in from the Sierra Nevada on the east are, Antelope, Dye, Mill, and Deer Creeks. The streams heading in the Coast Range and flowing east are the South Fork of Cottonwood, Red Bank, Elder, Thomas, and Dry Creeks. The streams having their sources in the Sierra run through steep and scraggy cañons, which open on the valley below in abrupt chasms, the lava flow from the volcanic cones to the east ending here in a bluff wall that stretches for forty miles along this side of the valley.

Besides a large area of the best farming lands in the State, Tehama County contains much good grazing land, the whole country, where not under the plow, being covered with wild oats and the indigenous grasses, on which large herds of horses, neat cattle, and sheep are pastured, the soil and the climate here being alike adapted for sheep raising, fruit and grain growing.

There is a large and valuable deposit of chrome iron existing in this county in T. 25 N., R. 7 W.

The principal towns in Tehama are Red Bluff, the county seat and head of navigation on the Sacramento, Tehama, Vina, location of Senator Stanford's large vineyard, Elder Creek, Henleyville, Moon's Ranch, and Sesma, there being a dozen of hamlets in the county containing from fifty to two hundred inhabitants each.

TRINITY COUNTY.

This county is bounded on the north by Siskiyou and Humboldt, on the east by Shasta and Tehama, on the south by Mendocino, and on the west by Humboldt County.

Trinity is a mountainous county, its eastern third being covered by the Coast Range, or Trinity Mountains, the summit of which divides this from Tehama and Shasta Counties. Bully Choop, Baldy, and other peaks in this range reach an altitude of over six thousand feet, some of the summits in

Salmon Mountains, in the northern part of the county, being still higher. The latter are also remarkably steep, shooting up in spires so precipitous that the snow is unable to lie upon them, but sliding off into the deep rents remains there all summer. The hydrography of this county is very simple, the Trinity River and its confluents draining all parts of it. Heading in the Scott Mountain division of the Coast Range, this river, after flowing south for sixty miles, makes a detour to the northwest, which course it holds for another sixty miles, when it passes into Humboldt County, uniting a little further on with the Klamath.

Nearly the whole of this county is heavily timbered with pine, spruce, fir, and cedar, oak and madrona forming a part of the forests at lower altitudes; while the wild grasses afford much pasturage. Trinity contains comparatively little good farming land, though for the hardier fruits both the soil and the climate are especially well adapted. As in most mining sections, the auriferous belt varies; some of the veins being in slate, some in granite, while others are on the contact between slate and granite. The deposits of gravel are as vast as any found in the State.

TRINITY GOLD MINING COMPANY.

This gravel mine is located four miles west of the town of Weaverville, in the Weaverville District. The claim has been worked for the past fourteen years. It was located in 1851 and incorporated in 1874. Before incorporation it was known as the Ward Placer Mine. The claim contains four hundred and thirty acres. The channel runs about east and west, extending from Oregon Gulch to Weaver Basin. On the summit of the mountain the gravel belt is about one half a mile wide. The altitude here is three thousand one hundred feet. The bedrock is clearly defined on both sides; its character is slate; the gravel belt tapers down to the foot of the mountain, a distance of three quarters of a mile. The altitude here is two thousand and fifty feet. From the summit to the gulch is an unbroken stratum of gravel, and is estimated to be from two hundred to four hundred feet in depth. At present the supply of water is insufficient to work the mine. The owners assert that with two thousand inches of water the property will produce $500 daily. An abundant supply of water can be brought from Cañon Creek, a distance of twenty-six miles, at an estimated cost of $150,000. Last year, owing to the light supply of water, the company worked only three hundred and sixty-nine hours, and produced, the Superintendent states, about $8,000.

M'MURRY & HUPP GRAVEL MINE.

This claim, one mile south of Weaverville, was located in 1853. The property consists of ninety-six acres of a sedimentary formation, the pay being gravel. The gravel is uncemented, and has a depth of from twenty-five to fifty feet. This claim has been worked for the past twenty-two years, producing a gross, stated, average of $2,500 per month. The pay channel is twelve hundred feet wide. Fifteen men are employed, at $2 50 per day, without board. It is believed that the product could be largely increased with an increased supply of water.

THE BARTRED MINE

Is located in the Deadwood Mining District. Formation of both walls are the same, being composed of porphyry and slate. The vein has an east

and west course, dipping to the south at an angle of 65 degrees, and an average width of about three feet. The mine is worked by tunnel and an incline shaft. The tunnel is five hundred and seventy-five feet in length, reaching a vertical depth from the surface of one hundred and twenty feet. The shaft is down two hundred and forty feet, reaching a vertical depth of two hundred and twenty feet. The ore shoot is five hundred and sixty feet in length. The company has built a road one mile in length, to transport ore from mine to mill. The claim is fifteen hundred feet in length by four hundred and fifty feet in width. The mill is a frame building, containing ten stamps, which are run by steam power. The sulphurets are saved on the Frue vanners. Of the gold recovered 95 per cent is saved in battery, and 5 per cent on outside plates. It is estimated that the ore contains 4 per cent sulphurets, composed of iron and galena, which are worked by the Plattner process, at an expense to the company of $22 per ton. The percentage of value recovered is 95.

Altitude	3,700 feet.
Length of ore shoot	560 feet.
Vertical depth reached in mine	220 feet.
Character of hanging-wall	Slate and porphyry.
Character of foot-wall	Slate and porphyry.
Kind of powder used	Giant.
Quantity of powder used	300 pounds per month.
Cost of mining	$4 50 per ton.
Cost of tunnel	$6 per foot.
Cost of shaft	$20 per foot.
Number of feet timbered	810
Kind of timber	Spruce.
Cost of timber	$20 per thousand.
Length of road built	1 mile.
Cost of transport of ore	40 cents per ton.
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamps	7 inches.
Drops per minute	86
Duty of stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Wire, No. 50.
Water used in battery	4 inches.
Dimensions of apron	4 by 5 feet.
Width of sluice	2½ feet.
Length of sluice	20 feet.
Kind of feeder	Roller.
Kind of concentrators	Frue.
Percentage of recovery saved in battery	95
Percentage of recovery saved on plates	5
Percentage of sulphurets	4
Value of sulphurets	$120 per ton.
Cost of milling	$1 50 per ton.
Cost of working sulphurets	$22 per ton.
Percentage of value extracted from sulphurets	95
Number of men in mill	5
Number of men in mine	19
Total number employed	24
Average wages in mine	$50 per month and board.
Average wages in mill	$2 to $3 per day.
Average wages paid outside work	$50 per month and board.
Wood used	2 cords per day.
Cost of wood	$2 75 per cord.
Quantity of water used in milling	8 inches.

BROWN BEAR MINE.

This property is located seven miles west of the town of Lewiston, in Deadwood Mining District, at an altitude of three thousand six hundred feet above sea level. The claim is one thousand five hundred feet in length by six hundred feet in width. The vein courses east and west, dips 65

degrees to the north, and has an average width of three feet. The tunnel, through which the mine is worked, is two thousand two hundred feet in length, and has reached a vertical depth from the surface of three hundred and seventy feet. Slate and granite constitute the formation of both walls; hanging-wall slate, foot-wall granite. Two hundred and fifty pounds of powder per month are used. The company has constructed a wagon road fifteen miles in length. The mill, containing fifteen stamps, is worked by steam power. They have in use two Triumph and two Frue concentrators. The method of treating sulphurets is by chlorination, at a cost of $22 per ton. Developments consist of two thousand two hundred feet of tunnel and one thousand five hundred feet of drifts.

Altitude	3,600 feet.
Length of ore shoot	1,400 feet.
Vertical depth reached in mine	370 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Granite.
Kind of powder used	Safety Nitro.
Quantity of powder used	250 pounds per month.
Cost of mining	$4 50 per ton.
Cost of tunnel	$3 per foot.
Number of feet timbered	900
Kind of timber	Spruce.
Cost of timber	$20 per thousand.
Length of road built	15 miles.
Cost of transport of ore	50 cents per ton.
Number of stamps	15
Weight of stamp	750 pounds.
Drop of stamps	6 inches.
Drops per minute	85
Duty of stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Slot punched, Nos. 8 and 10
Water used in battery	8 inches.
Dimensions of apron	3 by 5 feet.
Width of sluice	18 inches.
Length of sluice	16 feet.
Kind of feeder	Challenge.
Kind of concentrators	Frue and Triumph.
Percentage of recovery saved in battery	95
Percentage of recovery saved on plates	5
Cost of milling	$1 50 per ton.
Number of men in mill	5
Number of men in mine	33
Total number employed	38
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 to $3 per day.
Average wages paid outside work	$2 per day.
Wood used	3 cords per day.
Cost of wood	$2 75 per cord.
Quantity of water used in milling	15 inches.

BULLY CHOOP GROUP.

This property is located twenty miles southeast of the town of Ono, in Bully Choop Mining District, and consists of twenty different locations, each being one thousand five hundred feet in length by six hundred feet in width. The vein has a width varying from ten to fifty feet, a north and south course, and an easterly dip of 30 degrees. The property is worked through tunnels. The vertical depth reached from the surface is three hundred feet. As yet no walls have been found. The formation of the country is porphyry and slate. Developments consist of one thousand five hundred and eighty feet of tunnels. There is a ten-stamp mill on the property worked by steam power.

Altitude	6,200 feet.
Length of ore shoot	Not determined.
Vertical depth reached in mine	300 feet.
Kind of powder used	Hercules.
Quantity of powder used	Not stated.
Cost of mining	$1 per ton.
Cost of tunnel	$7 per foot.
Number of feet timbered	700
Kind of timber	Pine.
Length of road built	16 miles.
Cost of transport of ore	50 cents per ton.
Number of stamps	10
Weight of stamp—pounds	800
Drop of stamps	6 inches.
Drops	90 per minute.
Duty of stamp	2 tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Slot punched.
Dimensions of apron	4 by 4½ feet.
Width of sluice	2 feet.
Length of sluice	30 feet.
Kind of feeder	Challenge.
Kind of concentrators	Triumph.
Percentage of recovery saved in battery	90
Percentage of recovery saved on plates	10
Cost of milling per ton	Not stated.
Number of men in mill	5
Number of men in mine	20
Total number employed	25
Average wages in mine	$2 50 per day.
Average wages in mill	$2 50 per day.
Average wages paid outside work	$2 per day.
Wood used	6 cords per day.
Cost of wood	$3 50 per cord.
Quantity of water used in milling	Not stated.

GOLDEN CHEST MINING COMPANY.

Fifteen miles northwest of the town of North Fork is the location of this property. It is in the East Fork Mining District. The claim was located in 1887. The course of vein is northwest and southeast; dip is 80 degrees to the east. The vein will average one foot and a half in width. The claim is one thousand five hundred feet in length by six hundred feet in width. Length of ore shoot is not known. The mine is being prospected by tunnels, of which there are three run on the vein, twenty, sixty, and seventy feet in length, respectively. The hanging-wall is slate; foot-wall, porphyry. The company is erecting a five-stamp mill, which will be worked by water power. There is an eighty-foot fall of one hundred and eighty miner's inches of water.

Altitude	2,600 feet.
Length of ore shoot	Not determined.
Vertical depth reached in mine	60 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Porphyry.
Kind of powder used	Hercules.
Quantity of powder used, cost of mining, cost of tunnel	Not stated.
Length of road built	One half mile.
Length of ditch built	One half mile.
Cost of transport of ore	50 cents per ton.
Number of stamps	5
Weight of stamps	750 pounds each.
Drop of stamps	8 inches.
Drops	85 per minute.
Duty of stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Wire, No. 40.
Dimensions of apron	4 by 4½ feet.
Width of sluice	2 feet.
Length of sluice	16 feet.

Kind of feeder	Challenge.
Kind of concentrators	Triumph.
Percentage of gold saved in battery and on plates	Not stated.
Percentage of sulphurets	2
Cost of milling	Not stated.
Number of men in mill	4
Number of men in mine	12
Total number employed	16
Average wages in mine	\$2 50 per day.
Average wages in mill	\$2 50 per day.
Average wages paid outside work	\$2 per day.
Quantity of water used in milling	150 inches.
Fall of water used for power	80 feet.

NORTH STAR MINE.

This mine is located eight miles northwest of the town of North Fork, in the North Fork Mining District. The course of vein is northwest and southeast, dips to the east 75 degrees. The variation in width is from one to four feet. The claim is one thousand five hundred feet in length by six hundred feet in width. The owners are negotiating for a sale of the property, consequently the mine is not being worked. The altitude of the mine is two thousand and fifty feet. The claim was first opened by a tunnel, sixty feet in length, reaching a vertical depth from surface of fifty feet; here the vein is four feet wide. Afterwards an incline shaft was sunk on the vein to a depth of seventy-five feet, showing a uniform width of one foot all the way down; both walls are granite. On the property is a five-stamp mill, not in running order. Weight of stamp, four hundred and fifty pounds; drop in inches, six; drops per minute, eighty. The mill when running was worked by water power.

Altitude	2,050 feet.
Length of ore shoot	Not determined.
Length of ore shaft on incline	75 feet.
Vertical depth reached in mine	60 feet.
Character of walls	Granite.
Kind of powder used	Giant.
Quantity of powder used	50 pounds per month.
Cost of mining	\$1 50 per ton.
Cost of tunnel	\$6 per foot.
Cost of shaft	\$8 per foot.
Length of road built	1 mile.
Length of ditch built	½ mile.
Cost of transport of ore	50 cents per ton.
Number of stamps	5
Weight of stamps	450 pounds each.
Drop of stamps	6 inches.
Drops of stamp	80 per minute.
Duty per stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	No. 40. wire.
Dimensions of apron	4 by 4½ feet.
Width of sluice	4 feet.
Length of sluice	12 feet.
Percentage of recovery saved in battery	90
Percentage of recovery saved on plates	10
Percentage of sulphurets	Not stated.
Average wages in mine	\$2 50 per day.
Average wages in mill	\$2 50 per day.
Average wages paid outside work	\$1 50 per day.
Quantity of water used in milling	60 inches.
Fall of water used for power	80 feet.

ENTERPRISE MINE.

This property is located in North Fork District, nine miles northwest of the town of North Fork. The altitude is two thousand one hundred feet. Course of vein is northwest and southeast, and dips 20 degrees to the east. The vein varies from six inches to two feet in width. Development work consists of a tunnel two hundred feet in length, giving a vertical depth reached from surface of sixty feet. The ore, which the owner says has an average value of $100 per ton, is worked in an arrastra at the rate of one ton per day.

HAY FORK DISTRICT.

There are a number of locations in this district, the most prominent being the Cyclone and Magdalina. There has not been enough work done on either of them to determine their value. Where the vein is exposed it is small, but rich.

ALTOONA.

Sixteen miles northeast from Trinity Center is located the Altoona Cinnabar Mine. This property has not been worked for years, owing to litigation. Legal difficulties have at last been settled. It is said work will be resumed shortly. The deposit in many places averages twenty feet in width. It runs in a course northwest and southeast. The property was located August 8, 1872. The development work, from information obtained, consists of four thousand feet of tunnels, and drifts ranging from two hundred to five hundred feet in length.

BUCK MINE.

This property is located fourteen miles southeast from Weaverville, in the Indian Creek District. The vein has an east and west course, dips 75 degrees to the north, and is from six inches to two feet wide. The dimensions are one thousand five hundred feet in length by six hundred feet in width. The altitude is two thousand three hundred feet. Development work on the property consists of a tunnel two hundred feet in length, giving a vertical depth reached from surface of three hundred feet. The walls are of slate and porphyry. There is no mill on the property. Two men are at work prospecting the vein.

COAL.

Cox Bar is located twenty-seven miles west from Weaverville on the Trinity River. From time to time exciting reports have been circulated regarding coal discoveries in this section. Specimens of this coal have been used for blacksmithing purposes at Weaverville and other places.

TULARE COUNTY.

By W. A. Goodyear, Assistant in the Field.

A small part of what follows concerning this county is from old notes—date, 1870.

This county is bounded on the northwest and north by Fresno, on the east by Inyo, on the south by Kern, and on the west by Monterey and Fresno Counties.

The eastern half of the county lies in the Sierra Nevada. The western half extends across the Tulare Valley, and is all of it nearly level, except a small portion in the extreme west, which extends into the Coast Range. In the western portion of the county lies Tulare Lake, whose present dimensions do not exceed a length of about twenty miles in a nearly east and west direction, with a maximum width of perhaps sixteen or seventeen miles, its area being now only about one third as great as it was eighteen or twenty years ago, owing to the fact that of late years so much of the water has been taken out of the rivers which feed it, and spread over the country for irrigation purposes, so that it never reaches the lake.

The Mineral King Mining District is situated about the headwaters of the Middle Fork of the Kaweah River, distant sixty miles by a good wagon road, in a direction a little north of east from Visalia. Some of the distances, measured by odometer, on this road are as follows: Visalia to Lime Kiln Post Office, twenty miles; Lime Kiln Post Office to Three Rivers, seven miles; Three Rivers to Wm. Bahwell's place, three miles; Bahwell's to Judge T. Atwell's sawmill, twenty-four miles; sawmill to Mineral King, six miles.

On the southeast side of the Kaweah River, about one third of a mile above the Lime Kiln Post Office, in the foot of a low hill, is E. Jacobs' limestone quarry, with three kilns, which are said to hold about five hundred barrels each. No lime had been burned here for some time, but they were at work (June twenty-eighth) in the quarry getting out rock preparatory to burning lime again. The limestone is crystalline, rather coarse, and is inclosed in granite. Like all other deposits of its kind with which the writer is acquainted in the granites of California, the limestone varies much in quality, and much of it, though white enough, contains so high a percentage of silica that it will not make good lime; and the rock, therefore, requires careful sorting by an experienced eye before being sent to the kiln. It was ignorance of this fact, combined with the erroneous belief that a long-continued heat would spoil the lime, while an extremely high temperature for a short time in the kiln could do no harm, which led to a partial failure in the previous working of these kilns. The natural result was that by too fierce firing the interior of at least one of the three kilns was almost completely melted down, without getting good lime out of it after all.

From the foot of the mountains proper, up to Bahwell's, all the country is granite, with the exception of occasional small and irregular spots and belts of limestone and metamorphic schists.

Bahwell's is on the south side of the Kaweah River, the North Fork of which joins the Middle Fork just opposite his house. About three quarters of a mile below here Griffiths Cañon comes into the river from the north. About one and one half miles up Griffiths Cañon a locality was found where narrow belts of limestone, accompanied by veins of very coarse granite, traverse the country in a direction about south 70 degrees east, magnetic. The country here is generally a moderately fine-grained and rather dark-colored granite. But the veins above referred to are much coarser and nearly white in color, consisting mainly of quartz and feldspar, and containing crystals of garnet, epidote, and tourmaline, together with some cleavable calcite. Many of these crystals are large, the garnets being often an inch or more in diameter, the epidote one quarter to one half inch, and sometimes two inches long, and the tourmaline often one to one and one half inches in diameter and two to three inches long, while one crystal of tourmaline was seen which was not less than three inches in diameter and five or six inches long. The feldspar shows numerous cleav-

age planes, and the quantity of it, as well as that of the quartz, is great; but the quantity of mica in the veins is extremely small, though in much of the country rock around the quantity of mica is great. The crystals in these veins, however, are so firmly imbedded in the harder and less brittle quartz and feldspar gangue that it is almost impossible to get out good specimens of them. The dip of these veins and limestone belts is very high, probably 75 degrees or 80 degrees to the southwest. Bahwell's house is on the northeast quarter of the southwest quarter of Sec. 13, T. 17 S., R. 28 E., M. D. M.

There are in Tulare County a great many of the *Sequoia gigantea*, or "Big Trees," and they are there used to some extent for lumber. One somewhat noted locality, called the Giant Forest, is between the North Fork and the Marble Fork of Kaweah River, and probably on T. 16 S., R. 30 and 31 E., M. D. M.

Atwell's sawmill, at an altitude of about six thousand three hundred feet above the sea, has a capacity of about twenty thousand feet of lumber per day. The timber there is chiefly yellow and sugar pine, and fir. But there is also a good deal of *Sequoia gigantea*, some of the trees of which are eight or ten feet in diameter at a height of fifteen or twenty feet above the ground.

The village of Mineral King is in the bottom of a deep cañon a little over eight thousand feet above the sea. All the country around here is chiefly granite. A short distance below the village the road passes by a heavy deposit of calcareous tufa, formed by mineral springs now extinct. The granite varies a good deal in character. Some of it is porphyritic, with large crystals of feldspar, and it is frequently traversed by veins of feldspar and quartz.

Immediately around the village the tamarack, or *Pinus contorta*, flourishes to the height of one hundred to one hundred and fifty feet, and is the only tree. Higher up on the mountains, however, there are other kinds of timber.

The "Saw Tooth Peak," lying about three miles in an air line east of Mineral King, is said (probably with truth) to be about thirteen thousand two hundred and fifty feet above the sea.

Three mines about Mineral King were visited, viz., the Empire, the White Chief, and the Lady Franklin. The Empire Mine lies north 20 degrees east, magnetic, from William Corse's house in Mineral King, and about two thousand feet above it, thus being about ten thousand feet above the sea. From this mine some magnetic bearings were taken, as follows:

White Chief Mine, S. 11° E.; estimated air line distance, two miles.
Farewell Gap, S. 25° E.; estimated air line distance, three miles.
High Granite Peak at head of Hockett's Meadows, S. 13° E.; estimated air line distance, seven or eight miles.
"Homer's Nose," a high, round-topped peak just north of the South Fork of Kaweah River, S. 41° W.; estimated air line distance, six or seven miles.

The Empire Mine is a little higher than the White Chief, and is probably some two hundred feet lower than the summit of Farewell Gap, which last is the highest summit of the route, which, since the construction of the wagon road to Mineral King, has been generally followed across the western crest of the Sierra Nevada from Visalia to the great cañon of the North Fork of Kern River, instead of the old Hockett trail, which follows up the South Fork of the Kaweah; this route striking the North Fork of the Kern at the same point where the old Hockett trail did.

The Mineral King Mines are all of them in a belt of very highly metamorphosed calcareous slates and siliceous limestones, which strike from

north 30 degrees west to north 40 degrees west, magnetic, and dip southwesterly at high angles, ranging from 60 degrees upwards. The crystalline limestone seems to be very irregularly distributed through the slates, and I could not see any evidence of any well defined vein at the Empire Mine. Most of the gaugue taken out here, as shown by the waste heaps, is limestone; which, however, varies greatly in texture and composition, and is associated with a good deal of crystallized quartz, which is usually coated with oxide of iron.

The ore, properly so called, of the Empire Mine, so far as can be judged from fragments picked out of the old dumps, was chiefly zinc blende, with some galena and arsenopyrite, in the limestone, the blende greatly predominating. It is said to have been rich in silver, with some gold.

The mine was first opened about 1875. About 1879 a ten-stamp mill, adapted to the working of *free gold ores*(!), was built here, with a costly wire tramway one and a quarter miles long, to convey this complex ore from the mine to that mill, two thousand feet below! The writer well remembers the man who did this, when as a member of the Legislature at Sacramento he did everything in his power to prevent the State from appropriating any money for geological or mining investigations, believing all such work to be worthless folly. Yet, only a few years afterwards, he foolishly and ignorantly invested the bulk of his own fortune in such an experiment as this, and lost it, of course! The tramway and the mill have since been carried away by heavy snow-slides, and the mine has been idle for years.

A short tunnel was driven, and several small shafts sunk to depths of something over one hundred feet below the surface. It is not safe to explore these old works now. A short distance inside of the mouth of the tunnel, on July 1, 1888, huge icicles stretched from roof to floor. There is considerable epidote here. Inside of the belt of slates and limestones which inclose the Empire Mine, there is much fine-grained granite, and the slate, limestone, and granite are intermixed in most inexplicable confusion. It is hard to see how such granite can be deemed to have been a melted rock; and, difficult and obscure as the question is, it may as well be stated here as anywhere else, that a thousand geological and structural facts lead the writer to strongly suspect that the greater portion, if not the whole, of the granites of California are in reality metamorphic.

The White Chief Mine, now also idle, lies about south 20 degrees east from Mr. Corse's house in the village of Mineral King; and its altitude, as already stated, is but little less than that of the Empire Mine, viz., about ten thousand feet.

At the White Chief, a tunnel runs south 60 degrees west, magnetic, one hundred and ninety-five feet, the first one hundred and fifty feet of which are through solid marble, and the last forty-five feet in very hard syenitic granite, which contains considerable magnetic iron. The limestone belt here varies from one hundred feet or less to two hundred feet or more in thickness. It strikes about north 35 degrees west, magnetic, its southwest wall being the syenitic granite, while its northeast wall consists of slates standing nearly vertical. Large irregular bunches of slate are also interpolated in the midst of the limestone. The surface of contact between the limestone and the granite dips very steeply to the southwest, and it is in the limestone close to this contact surface that the complex ore has been found. It consists chiefly of galena and zinc blende, with some arsenopyrite, and is believed to carry an average of some $35 per ton in silver, with a little gold. Other minerals also occur, such as epidote, garnet, limonite, tourmaline, pyromorphite, etc.

The Lady Franklin Mine lies about one and three fourths miles north 42 degrees east from the White Chief, and on the opposite, or eastern, side of the main cañon leading up to Farewell Gap. It is on a branch cañon which drains Silver Lake, and comes into the main cañon from the southeast. It is in a belt of thin-bedded limestone intercalated between the slates, and only about twenty feet thick, which strikes about north 60 degrees west, magnetic, and at this point dips 75 degrees or so to the northeast. The slates extend something like three fourths of a mile northeast from here, where the granite comes in again; the whole width of this belt of slates and limestones being perhaps two or two and one half miles. The only productive layer at the Lady Franklin is a stratum about three feet thick on the foot-wall of the limestone. Along the eastern edge of the slate belt, and near the granite, the alternating strata of limestones and slates are bent, crushed, and twisted into many fanciful shapes. In one place on the mountain side three fourths of a large oval is visible, and in other places all sorts of irregular curves occur in the strata.

The ore at the Lady Franklin is very heavy, but is finer grained than that at the White Chief, and contains apparently much less lead and zinc, but more arsenopyrite, and perhaps some copper.

A stream of water which drains some snow fields to the west of the White Chief Mine, has found an underground channel for a considerable distance through the limestone at a depth of several hundred feet beneath the crest of a high ridge, and now bursts out of the mountain on the southwest side of the main cañon, about one fourth of a mile above Mr. Corse's house, and some three hundred or four hundred feet above the bottom of the valley, discharging, I judged (July 2, 1888), from two hundred to three hundred miner's inches of water, which makes a beautiful cascade down the mountain side. But beautiful cascades are plenty in these high mountain regions, whence the snow banks never entirely disappear.

There is much epidote in some of the hard slates around here. No mining is being done here now except simply "assessment work" to hold the claims.

It must not be inferred from anything which has been said, that the writer considers the Mineral King Mining District a worthless one: on the contrary he thinks it promises fair. But work enough has never yet been done there to prove how much ore can or cannot be obtained, and certain it is that no ordinary gold or silver mill will ever extract the metals from such complex ores. If they are ever treated successfully at all, it must be by fire.

A very interesting locality visited in Tulare County is Clough's Cave, in the limestone on the right (or north) bank of the South Fork of the Kaweah River, about fifteen miles above Three Rivers Post Office (where the South Fork joins the main river), and close by the old Hockett trail, which here follows up the south side of the cañon.

The mouth of the cave is some three thousand eight hundred or three thousand nine hundred feet above the sea, and one hundred and seventy-five or two hundred feet above the bed of the river, in an extremely steep mountain side. The opening in the face of the cliff is small, only about four by two feet. But inside, the cave quickly widens out into an irregular series of chambers and corridors, which wind crookedly about, constantly more or less ascending or descending, and extend for a distance of probably not less than one thousand feet into the mountain. Many fanciful forms of stalactite and stalagmite, corrugated floors and festooned roofs, can here be seen. Many of the stalactites, when struck a light blow, ring with a clear bell-like tone, others do not. Many are beautifully and coarsely

crystallized; others are not so, but show a delicate, concentric structure. Many of them have a straight cylindrical hole about the size of a wheat straw running longitudinally through their center from top to bottom, and in such cases the tip at the bottom of the stalactite is concave. Some of them are pure white, others of a pinkish tinge; and some of the broad and flat ones (of which there are many) are translucent, and of a most beautiful pink or rosy color by transmitted light. Many of the coarsely crystallized, dome-shaped stalagmites glisten magnificently in the lamp light. The different tones given out by the ringing stalactites are generally as clear and pure as those of a bell or a fine piano, and a range of two or three octaves can easily be found between different stalactites. Some of the stalactites also have little side branches, or prongs, the tips of which are turned *upwards*.

The quantity of water in the cave now is extremely small, only just enough to keep the surface of the stalactites in some places wet, with a drop of water constantly hanging at their tips, from which it falls only at long intervals. In places the floor has a very hollow sound. There is now and then a streak of sand traversing the limestone walls, and occasionally a seam of micaceous clay resulting from the decomposition of the adjacent granite country, which has found its way through cracks into the cavern.

The body of limestone in which this cave exists is of course of considerable magnitude, and it is accompanied by some slates; but most of the surrounding country is granite, as it is nearly all the way below here along this fork of the river. I greatly regretted not having more than about an hour and a half to spend inside of this cave, for it is a place where a week might be spent to advantage, and something new learned all the time.

Mr. Clough, I believe, claims the proprietorship of this cave. At all events, he has a strong door at the mouth of it, which he usually and wisely keeps locked; for if it were accessible to the general public without a guard, common vandalism would quickly destroy its finest gems. If it were in a more easily accessible locality, it would be a very valuable possession as a curiosity. But it is about fifty miles from the nearest railroad station, in a very rough country, and the present trail leading to it is vile, and somewhat dangerous.

Occasional cubes of oxide of iron, resulting from the decomposition of iron pyrites, occur in the walls of the cave, and some stalactites were seen, which, instead of being hard with either a crystalline or concentric structure, were almost pulverulent and could be easily crushed with the fingers.

The following facts concerning a portion of Tulare County are taken chiefly from the writer's hitherto unpublished notes of April and May, 1870:

Entering the county from the northwest, near Bliss' old ferry, on Kings River, not far from the town of Kingston, and following the then stage road, from Kings River to Cross Creek (twelve and two thirds miles) the soil is rather sandy, and half a dozen or more small creeks and sloughs were crossed which (April 30, 1870) had more or less water in them. For about six miles northwest and eight miles southeast of Cross Creek there is no timber, the plain being covered only with grass and herbage. A few willows, etc., mark the line of Cross Creek.

Visalia (twelve miles from Cross Creek) is in the midst of a fertile and beautiful country, timbered with magnificent oaks, and watered by the delta-branches of the Kaweah River, which, instead of following a single channel to Tulare Lake, divides into several forks which water the country around Visalia, and afterwards lose themselves in the swampy region to the southwest, between Visalia and the lake.

In 1870 Visalia had the reputation of being quite an unhealthy place, malarial and intermittent fevers being prevalent. But its reputation in that respect has greatly improved since then, owing, probably, to the facts that some system of drainage has been adopted, and the surface water is no longer generally used for drinking and domestic purposes, nor allowed to stand around in stagnant pools, as it then sometimes did all summer long.

From Visalia to Connor Station (called, also, the Eighteen-mile House) the distance by odometer was about seventeen miles; and from thence to Vandalia, on the left bank of the Tule River, at the ford, a mile or so beyond Portersville, about ten and one half miles.

For the first six or eight miles from Visalia the country is well timbered, but beyond this it is again naked and bare. For several miles on both sides of Connor Station the road passes through a region of what are popularly called "hog wallows," where the whole surface of the ground is a mass of thickly, but irregularly scattered and irregularly shaped, low rounded hillocks, from one to four or five feet high and from ten feet or less to fifty feet or more in diameter. Why these little hillocks should ever have been called "hog wallows" it is difficult to conceive, unless it were upon a principle of "*lucus, a non lucendo*;" for they do not resemble "wallows" of any sort, nor has any "hog" had anything to do with their formation. Many silly theories have been propounded for their origin, some of these theories involving cataclysmal earthquakes, others a supposed submarine "rooting" of whales or other marine animals, and still others involving equally groundless nonsense. I confess that the first time I ever saw them they puzzled me; but since then I have seen them in many parts of California, Oregon, and Washington Territory, and more than once—in Owens Valley and other regions, not to mention the sand dunes of San Francisco itself—in course of actual formation. They are simply collections of drifting sand and dust which have in time past been piled up by shifting and variable winds around every clump of brush or weeds which once grew there, but which have since died and entirely disappeared, leaving only their mounds behind to prove their former existence.

From Vandalia to Deer Creek is seven miles. Shortly after leaving Deer Creek we struck the southwestern edge of the granite country of the Sierra Nevada, and from there on to the White River, and through Lynn Valley, on the road to Kernville, almost the whole country is granite.

The following article is here reprinted, most of the region to which it relates lying in Tulare County:

"[From the Proceedings of the California Academy of Sciences, November 3, 1873.]

"NOTES ON THE HIGH SIERRA SOUTH OF MOUNT WHITNEY.

"By W. A. GOODYEAR.

"The following observations relating to the region south of Mount Whitney, and traversed by the Hockett Trail, between the Kern River and the eastern foot of the Sierra Nevada, were made during my trip with Mr. Belshaw into the mountains last July, when we climbed the supposed Mount Whitney, and discovered the mistake respecting it.

"It is well known that at about the headwaters of Kings River, the summit of the Sierra Nevada forks into two great ridges of nearly equal height and grandeur, which then extend far southeast toward Walker's Pass, though gradually diminishing in altitude after passing the summits of Mount Whitney and Kaweah Peak.

"For a long distance the crests of these two ridges vary from ten to fifteen miles apart, and are separated from each other by the tremendous cañon of the Kern River, which lies between.

"The culminating points of the eastern ridge are the Kearsarge Mountain, Mount Tyndall, Mount Williamson, Mount Whitney, the peak which has been mistaken for Mount Whitney, and a few other unnamed peaks. Those of the western ridge are Mount King, Mount Gardner, Mount Brewer, Kaweah Peak, etc.

"The Hockett Trail crosses the summit of the eastern ridge at an altitude of probably a little over eleven thousand feet, at a point nearly opposite the center of Owens Lake, and a few miles southeast of the peak which has been mistaken for Mount Whitney.

"We followed this trail to the locality known as Soda Springs, upon the main Kern River, which here flows at an altitude of between six thousand and seven thousand feet above the sea.

"Throughout this section of the country, the mountains, so far as seen, consist entirely of granitic rock, with the exception of a single, isolated and somewhat remarkable cluster of volcanic outbursts, at an altitude of about nine thousand feet above the sea. This cluster consists of four crater cones of moderate size, resting on the granite, and one basaltic lava-flow of considerable magnitude. The first of these outbursts seen in following the trail from Lone Pine, is some five or six miles east of the Kern River, and its altitude is probably a little over nine thousand feet. It forms the whole western half of a hill some three hundred or four hundred feet high, and reaches to its summit; while the whole eastern half of the same hill is naked, solid granite. This outbreak seems to be small and local, being apparently but a few hundred yards in extent in any direction; its length north and south, however, being considerably greater than its breadth east and west. Its situation on the hillside is peculiar. It appears as if a short fissure had opened here, in a northerly and southerly direction along the western slope of this hill, pretty well up toward its summit, and just enough material been ejected through it to cover the whole western half of the hill, without, however, sufficient explosive force to scatter it much in any direction.

"About a mile to the south of this hill are two twin crater cones, which I did not visit, standing close together, and nearly equal in height.

"Following along the trail, we find at the distance of about a mile westerly from the first hill mentioned above, another crater cone, some four hundred or five hundred feet in height, and perfect in form, except that a breach has been made in its northeast side and deepened nearly to its base. From the immediate vicinity of the base of this cone a lava stream has issued and flowed for some four or five miles in a nearly true west course, following the valley of a preëxisting creek to the main Kern River, where it now ends in a bluff facing the river, but high above its bed.

"Appearances indicate that in this case the lava stream issued first, and that after it had ceased to flow, the cinder cone was piled up over it at the point of ejection, the completion of the cone finishing the eruption.

"The valley followed by the flow was rather broad, and the quantity of lava was large, filling the bottom of the valley, spreading out in places to half or three quarters of a mile in breadth, and varying in depth from a few feet to two or three hundred feet at different points. The valley had a rapid fall toward the Kern River, and the bluff, which now forms the end of the flow, is one thousand five hundred feet or more below the point of issue.

"This eruption is of very recent geological age, far subsequent in date to the great volcanic period which covered the northern Sierra with such vast quantities of eruptive matter; for, throughout the central counties of the State, this period was substantially closed before the excavation of the modern cañons began; while this eruption occurred very late in the history of the formation of these cañons. Yet, if we could determine the years that have passed, we should find it old enough as compared with the life of a man; for since it happened, the little stream whose bed it followed has not only cut through it here and there, but near its mouth has eaten its way two or three hundred feet deeper than before into the solid granite under it. How far down the cañon of the Kern River itself the flow may have originally extended it is impossible to tell; for the river, in deepening its own cañon, has here swept it all away.

"For a considerable portion of the way where the bottom of the lava is now exposed, it rests upon heavy masses of calcareous tufa, previously deposited by mineral springs; and I noted, as an interesting fact which I do not pretend to explain, that at a point where I examined the tufa, in immediate contact with the overlying solid lava, I could detect no physical change in it, such as might have been expected from the heat to which it must have been exposed; but it appeared just like the same tufa in other places where the lava had not touched it. Neither shall I attempt to answer the puzzling question, *why* this little cluster of volcanic outbreaks should occur away up here, in the heart of the solid granite range, nine thousand feet above the sea, and with nothing else volcanic, so far as I know, within less than thirty or forty miles of it in any direction. I only note the fact.

"Another point of some interest is the fact that, though I hunted for them, I found no glacial scratches, nor any other evidence of the former existence of glaciers anywhere in this portion of the mountains; not even on the peak which has been mistaken for Mount Whitney, and which is over fourteen thousand feet high; nor on the top or sides of another peak which I climbed in the *western* summit, four or five miles northwest of Soda Springs, and which cannot be much less than twelve thousand feet high; nor in the cañon of the Kern River—which I followed for four or five miles—nor anywhere I went, did I find any traces of glaciers. This is certainly somewhat remarkable, when we consider the fact that the mountains only twenty miles to the north, though no higher than some of these, are, according to all accounts, full of glacial markings. It is true that much of the granite in the region where I traveled is comparatively soft, and disintegrates rapidly from weathering; but this is by no means the case with all of it, and much of it is as hard, and as well adapted to preserve such markings, as any in the Sierra. The fact, therefore, of their general if not total absence from this region certainly means something. It does not, of course, prove that glaciers have never existed here, nor that they may not have existed here for a very long time; but it does argue that if they have, then, owing to some cause not yet explained, they disappeared from this region long before they did from the mountains a few miles further north.

"The general character and appearance of that noblest portion of the Sierra, a few miles to the north of the peaks I climbed, have been already described in the Geological Survey Report and elsewhere; but no words can convey an adequate idea of its wild and majestic grandeur. It must be seen in order to be understood. I will only add, that its topography has never yet been worked up with anything like the accuracy of detail which is desirable for California's sublimest peaks, and it would be well if

the Geological Survey had the means to send a party to spend a whole summer there, to do it."

TUOLUMNE COUNTY.

The name Tuolumne, of Indian origin, was first applied to the principal river which drains this county. This county is bounded on the northwest by Calaveras, on the northeast by Alpine and Mono, on the south by Mariposa, and on the southwest by Stanislaus.

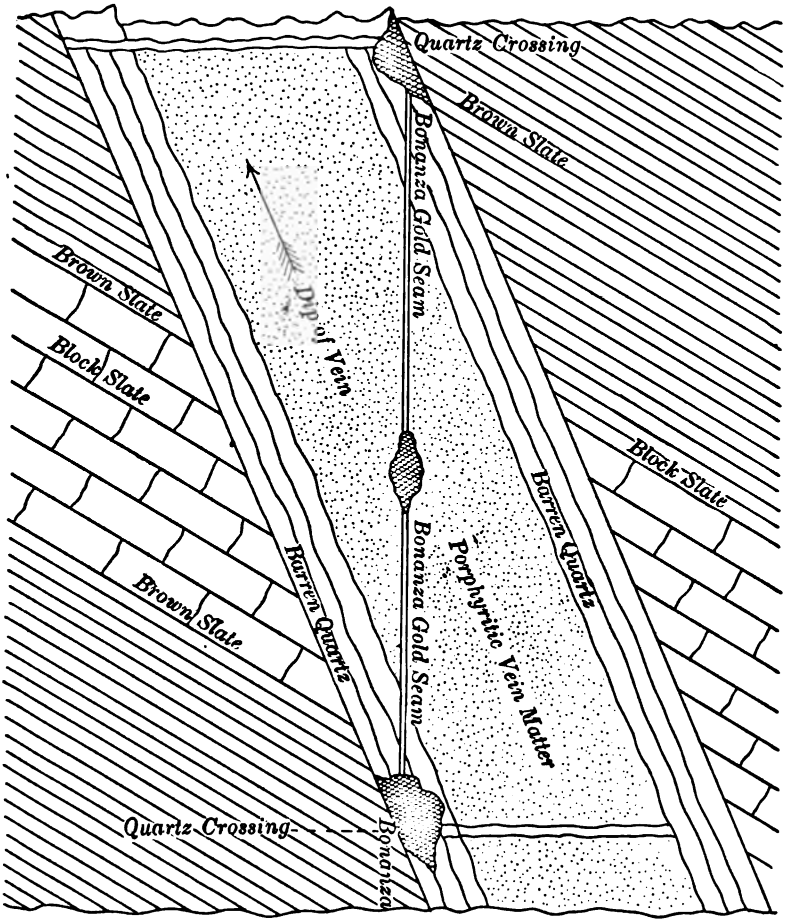
Like most of the counties lying along the main gold belt, Tuolumne covers a portion of the foothills and the westerly slope of the Sierra Nevada, giving to the whole county a rugged surface, and to the eastern portion of it a considerable altitude. In the Sierra Nevada, on the confines of this and Mono County, stands Mount Dana, thirteen thousand two hundred and twenty-seven feet high, with Castle Peak, a little further north, and nearly as high. A remarkable feature in the topography and geology of this county is the basaltic mesa, known as Table Mountain, which, running near and parallel with its northwestern boundary, extends for a distance of nearly thirty miles. This formation consists of a lava flow, which, having filled the channel of an ancient river, stands now, through the degradation of the adjacent country, an isolated mass, its top nearly level and its sides nearly perpendicular, the former more than two thousand feet above the bed of the Stanislaus, which breaks through it.

Flowing through this county in a westerly direction is the Tuolumne River with its three forks, also the three forks of the Stanislaus, all large streams; the main Stanislaus and its north fork forming in part the boundary between this and Calaveras County. As these several rivers have many confluents, some of them considerable streams, this becomes a well watered county. About the sources of the Tuolumne River are many small lakes, some very deep, and all remarkable for the purity of their water. As Tuolumne is well supplied with water so is it also abundantly timbered; the more elevated portions of it being covered with pine, fir, spruce, and cedar, and the lowest portions with scrub pine and oak. While gold mining continues to be in the county the leading industry, farming, viticulture, fruit growing, lumbering, and stock raising are here important and growing pursuits, many of the inhabitants dividing their time between these vocations and mining.

The principal towns in this county are Sonora, the county seat, Columbia, and Jamestown.

THE BONANZA MINE.

This mine is situated in the town of Sonora, at an altitude of about one thousand nine hundred feet. It has been worked from time to time since its discovery, in 1850, and has yielded wonderful returns in gold. It was found by tracing quartz gold up one of the gulches entering the town. It is purely a "pocket mine," in which the vein matter is entirely barren of precious metal, excepting in certain places of limited extent, but of great richness. It has been worked for so long a time, and has afforded so many successful finds, that rules, governing the occurrence of the aggregation of gold in this rock generally, have become so well understood that as little risk is taken in the exploration of this mine as attends operating any mine in which the gold is pretty uniformly distributed. The course of the vein is north 30 degrees east, and the dip is north 60 degrees west, inclining from 15 degrees to 28 degrees, averaging about 23 degrees with the horizon.



SECTION ON COURSE OF VEIN SHOWING BONANZA OCCURRENCE, BONANZA MINE, TUOLUMNE COUNTY.

The width of the vein matter is about twelve feet; the dimensions of the claim are about four hundred feet in length by sixty feet in width. In gold-bearing veins generally, there are chimneys of ore in which the rock is richer than in other parts of the vein. They may be of horizontal or vertical occurrence, or, as is usual, may "pitch" or incline at an angle with the course of the vein. Again, many gold-bearing veins, exhibiting great strength, may comprise all of their gold content in bunches of most irregular occurrence, to which no law of incidence is applicable, but it has been discovered by many years of exploration that the pockets in this mine do not exist anywhere, like accidents, but follow a law, as may be seen in the accompanying drawing, less variable than the dip of a ledge or the pitch of a chimney. The vein, in its dip, cuts parallel bands of block slate and brown slate, standing at an angle of 60 degrees or more. The brown slate is in narrow belts about twelve feet in width. The vein, which is composed of narrow strips of quartz on the hanging and foot-wall sides, separated from each other by porphyritic material, is crossed at times with

narrow stringers of quartz called "crossings," and traversed, nearly horizontally, by small seams stained with oxide of iron, called "gold seams." It has been found that whenever a quartz crossing, a gold seam, and a hanging or foot-wall conclude within a belt of brown slate, a bonanza occurs. These conditions have never failed thus far to result in a pocket, and all are essential elements of its occurrence, with one exception, when gold was found in the porphyritic material, on the line of the gold seam midway between the coincidences with the hanging and foot-walls.

The mine is opened by a tunnel, driven five hundred feet through block slate, reaching the vein at about eighty feet below the surface, and by an incline shaft sunk about four hundred feet on the vein. The vertical depth from the surface attained by the workings of the mine is about eighty feet. The mine yields about thirty-five thousand gallons of water daily, which is raised by means of a No. 4 Hooker steam pump, requiring one half cord of pine wood, costing $4 50 per cord. Safety Nitro powder, No. 2, is employed as a blasting agent. Augers are used for boring holes where the soft ground occurs, and inch steel for drilling in the hard rock. The incline is timbered with yellow pine, which costs delivered $20 per thousand. Nine men are employed in the mine, besides the lessees who are also engaged in work in or about the mine. The wages are $3 per day. The ore contains, besides the iron pyrites, which occurs with the gold in the pockets, tellurides of gold and silver. The richest of the rock is crushed in hand mortars, and the rest in the vicinity of the pockets is crushed in a stamp mill and worked in an amalgamating pan. The cubic feet in these pockets are very few, but the last two or three taken out by the lessees in a little over a year, yielded, it is said, $114,000.

The gold obtained in the mortars from this mine runs from 824 to 874 in fineness. The rules governing the occurrence of pockets in the Bonanza Mine apply to other pocket mines in the same belt, but not to mines in Brown Flat, on Bald Mountain, near Sonora. These mines have pockets with other modes of occurrence. The veins in which they here occur have a course of north about 40 degrees east, and the country slate north about 40 degrees west, the veins dipping northwesterly at an angle with the horizon of about 10 degrees. The pockets are usually found near where granite and quartz "crossings" intersect the vein in what is called "metallic slate." A large portion of the inhabitants in this part of the county are engaged in what is usually a remunerative search for gold existing under conditions as described, and a considerable part of the prosperity of Sonora is due to pocket mining, combined with the knowledge from local experience as to favorable conditions under which to find "pockets."

THE SAN GUISSEPPA MINE.

This mine was first located in 1851. It is situated in the Tuolumne Mining District, within the limits of the town of Sonora, about one quarter of a mile northwest of the center. The course of the vein is east and west, and the dip south, at an angle of 75 degrees; the average width is twelve inches. The claim is a full claim, one thousand five hundred by six hundred feet. The length of the ore shoot is one hundred and twenty feet. The mine is worked through a shaft, which is vertical for the first forty feet, and follows the vein for ninety feet further, to a depth of one hundred and thirty feet below the surface. The hanging and foot-walls are hard slate. About twelve thousand gallons of water are raised daily by a four-inch Cornish pump, with a three-foot stroke. Fifty pounds of Giant powder,

Nos. 1 and 2, are consumed monthly, and the average cost of mining is from $10 to $15 per ton. The shaft, which is four by eight feet in the clear, was sunk at the rate of five feet per week; the cost of sinking was $20 per foot; the shaft is timbered throughout with sawed yellow pine, which has a cost of $20 per thousand, and is hauled about twenty miles. The ore is a hard quartz, containing no free gold, but about 3 per cent of base sulphurets of good grade are contained in the ore, which does not work at all without roasting. The gold from this mine contains less silver than any gold obtained elsewhere in the State by amalgamation. A copy of certificates of fineness in gold of the bullion produced by amalgamation process used in working the ore, is here appended, covering a period of over three years, and representing bullion deposited with Professor Thomas Price and the United States Mint: 1885, average, 981.1 fine, $20 28 per ounce; 1886, average, 982.95 fine, $20 32 per ounce; 1887, average, 983.9 fine, $20 34 per ounce; 1888, average, 985.5 fine, $20 37 per ounce.

The ore is roasted in a cupola furnace, as it comes from the mine, without preliminary crushing; wood is used for fuel, but no blast is employed. A fire is first started in the bottom of the furnace and allowed to burn until a good bed of coals is obtained, then a layer of wood, cut in two-foot lengths, is thrown in; then a layer of ore about a foot thick, then wood and ore alternately until the furnace is filled to the "feed door." The layers of ore contain from one half to three quarters of a ton each. The charge is allowed to "burn" for forty-eight hours, and then it is used in supplying an arrastra, which works one ton in twenty-four hours. The ore by this treatment usually yields from $20 to $40 per ton in amalgam, the tailings assaying from $12 50 to $20 per ton, and canvas concentrations, of which a small amount per day is caught, contain from $400 to $500 per ton. The mill consists of an arrastra, ten feet in diameter, with three-foot bed, driven by a twenty-foot overshot wheel, which also furnishes power to the hoisting works; canvas-covered sluices, and one square foot of copper plate at the end of the sluice, complete the gold-saving appliances. The roasting furnace is constructed of common brick, four feet in diameter inside measurement, with a height of twelve feet from the discharge to the "feed door;" it has a capacity for roasting from five to six tons of ore, with which it is charged each time, requiring forty-eight hours and one cord of wood in the performance of the work. Two men are employed in the mine, one in the mill (the owner), and one on outside work; $2 50 per day is paid in the mine, and $1 50 on outside work; the wages of the millman, who is owner, is whatever net profit arises from working the ore. One fifth of a cord of pine or oak wood is used per day, costing $5 per cord. The hoisting machinery is straight cogwheel gear, with a drum fifteen inches in diameter, driven, in conjunction with the arrastra, by water power; the pump is driven by a separate overshot wheel, eleven feet in diameter; the water required for all purposes is from seventy to eighty miner's inches per diem, for which $15 per month is charged.

Altitude (aneroid reading)	1,800 feet.
Length of ore shoot	120 feet.
Length of ore shaft on incline	130 feet.
Vertical depth reached in mine	About 130 feet.
Quantity of water raised in twenty-four hours	12,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Giant, Nos. 1 and 2.
Quantity of powder used	50 pounds per month.
Cost of mining	$10 to $15 per ton.
Cost of shaft	$20 per foot.
Number of feet timbered	130

Kind of timber	Sawed yellow pine.
Cost of timber	$20 per thousand.
Character of ore	Quartz, sulphurets, and tellurides, with absence of free gold.
Character of works	Cupola furnace and arrastra.
Ore treated in twenty-four hours	1 ton.
Kind of concentrators	Canvas covered sluices.
Percentage of sulphurets	2 to 3
Value of sulphurets	$400 to $500 per ton.
Cost of milling	$4 50 per ton.
Kind of roasting furnace	Cupola, 4 by 12 feet.
Number of roasting furnaces	1
Wood consumed in roasting	⅛ cord per ton of ore.
Number of men in mill	1
Number of men in mine	2
Number of men employed on outside work	1
Total number employed	4
Average wages in mine	$2 50 per day.
Average wages paid outside work	$1 50 per day.
Wood used	¼ cord per day.
Cost of wood	$5 per cord.
Quantity of water used for power	70 to 80 miner's inches.
Cost of water for milling and for power	$15 per month.

THE PATTERSON MINE.

This mine was located in 1856, and is situated one half mile west of Tuttletown, in the Tuttletown District, along the main stage road from Copperopolis, Calaveras County, to Sonora. The course of the vein is northwest and southeast, and the dip easterly, at an angle of about 45 degrees. The dimensions of the claim are nineteen hundred and fifty feet in length by three hundred in width. The mine is worked through a tunnel and incline shaft, the length of the tunnel being about five hundred feet, reaching a depth of about eighty-five feet, measured vertically below the surface. The incline shaft has a total depth of about seven hundred and twenty feet, measured on the incline, reaching a vertical depth in the mine of five hundred and nine feet; it intersects the tunnel, one hundred and twenty feet of the incline being above the tunnel and six hundred feet being below it. The country rock is slate. The formation of the walls is irregular and indefinite. It is estimated that about twenty-five or thirty thousand gallons of water come in the mine every twenty-four hours, which is raised by a six-inch Cornish pump. Safety Nitro powder is the blasting agent employed, and "bull pine" the material used for timbering. Both shaft and incline are fully timbered. Where round timber is used the rate is not fixed; sawed lumber is delivered at $20 per thousand. The quartz is tolerably soft in character, mixed with slate, and bearing a large percentage of low grade iron pyrites. The ore, after being extracted from the mine by way of the incline shaft and tunnel, is dumped over a "grizzly," which separates the coarser from the finer, the finer going directly to the self-feeders by gravity, while the coarser is broken in a Brodie breaker before passing to the feeders. The ore is then pulverized in the battery, and the gold recovery collected therefrom and from the outside plates, the sulphurets being recovered by the Morris system of canvas-covered sluices, and subsequently worked by the pan process. The mill consists of one Brodie crusher of large size, four Challenge feeders, twenty eight hundred-pound stamps, which drop six inches eighty-five to ninety times per minute, and crush two tons of ore per stamp in twenty-four hours. Both iron and steel are used for shoes and dies, steel costing 8 cents per pound and freight from San Francisco, say ½ cent more per pound, and the iron costing 5 cents per pound, one set of iron shoes and dies lasting six weeks and crushing about one thousand six hundred and eighty tons; while one set of the Brooklyn chrome steel shoes and dies is said to have

lasted fourteen months and worn even, which indicates a crushing of sixteen thousand eight hundred tons, or just ten times the amount crushed by the iron.

A set of shoes for eight hundred-pound stamps, made of white iron, weigh about	2,500 pounds.
A set of dies for eight hundred-pound stamps, made of white iron, weigh about	2,300 pounds.
A set of white iron shoes and dies weigh	4,800 pounds.
A set of chrome steel shoes will weigh from 8 to 10 per cent more, or	5,200 pounds.

This would give the wear for iron shoes and dies two and eighty-five one hundredths pounds per ton of ore crushed, equivalent, at 5 cents per pound, to 14¼ cents; while the wear of the steel is stated to be about thirty-one one hundredths of a pound per ton of ore crushed, at 8½ cents per pound, 2.63 cents. The screens used are brass wire, No. 50, six by forty-eight inches inside of the frames, and are placed vertically. The aprons are forty-eight inches wide and seventy-two inches long; the sluices forty-four inches in width and fourteen feet in length. The plate used inside of the battery is six inches wide by forty-eight long. All of the plates are of copper, and the aprons and sluices have a grade of about one inch to one foot. Fourteen men are employed in the mine; four in the mill; in all eighteen. The wages paid per day in mine and mill are from $1 50 to $3 50. The motive power of the mill is water, which is applied to a Knight wheel, under two hundred and thirty feet of pressure. The daily volume of water required for power and batteries is seventy miner's inches, costing 8 cents per inch. The measurement used is four inches above the top of a three-inch slot in a two-inch plank. A very ingenious rotary screen (Hunt's patent) driven by the water of the flume, removes all debris from the water, and prevents any obstruction of the nozzle through which the water impinges on the wheel.

Altitude	1,250 feet.
Length of ore shaft on incline	720 feet.
Vertical depth reached in mine	509 feet.
Quantity of water raised in twenty-four hours	25,000 to 30,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Safety Nitro.
Number of feet timbered	Approximates 1,200 feet.
Kind of timber	Bull pine.
Cost of timber	$20 per thousand, sawed.
Character of ore	Free milling and pyritiferous rock.
Character of works	Water power mill.
Number of stamps	20
Weight of stamp	800 pounds.
Drop of stamps	6 inches.
Drops	85 to 90 per minute.
Duty of stamp	2 tons in twenty-four hours.
Kind of shoes and dies	Chrome steel and iron.
Size and character of screens	No. 50 brass wire.
Water used in battery	6 miner's inches.
Dimensions of apron	48 by 72 inches.
Width of sluice	44 inches.
Length of sluice	14 feet.
Kind of feeder	Challenge.
Kind of pans	Knox.
Number of pans	1
Kind of concentrators	(Morris patent) canvas-covered sluices and riffle sluices.
Number of men in mill	4
Number of men in mine	14
Total number employed	18
Average wages in mine	$1 50 to $3 50 per day.
Average wages in mill	$1 50 to $3 50 per day.
Quantity of water used in milling	6 miner's inches.
Head of water used for power	230 feet.
Quantity of water used for power	64 miner's inches.
Cost of water for milling, and for power	70 miner's inches, at 8 cents per twenty-four hours, $5 60

THE MADRID MINE.

This mine, located in 1886, is situated in the Tuttletown Mining District, three quarters of a mile west of Tuttletown, on the main road connecting Copperopolis and Sonora. The size of the claim is three thousand feet in length by six hundred in width. The course of the vein is northwest and southeast, and the dip is to the easterly, about 45 degrees. The ore shoot is about one hundred and twenty feet long, as far as developed, and its average width is from two to three feet. The mine is opened by a tunnel one hundred and twenty feet long, intersecting the vein about seventy-five feet below the surface, and a winze sunk forty feet below the tunnel, on the dip of the ledge. The tunnel and winze are timbered, the material costing the same as at the Patterson, an adjoining mine. The walls are of slate. Safety Nitro powder and three-quarter inch drill steel is used. The ore is free milling quartz, bearing low grade iron pyrites in small quantity. The ore is subjected to the simple free gold amalgamation process. The mill consists of five six hundred and fifty-pound stamps, driven by water under one hundred and twenty feet of pressure, thirty inches being required for power and battery. The stamps drop five inches eighty-five times per minute, each crushing about one and one half tons of ore per day of twenty-four hours. Iron is used for shoes and dies at a cost of 5 cents per pound; the shoes and dies last about six weeks. About one inch of water is used in the battery; the screens are No. 50 brass wire; the outside plates are silvered, both those on the apron and sluice; the dimensions of the apron are eight feet by four feet; the sluice is fourteen inches wide by fifteen feet long. Two men are employed in the mine and two in the mill. The wages paid per day in the mine and mill, $2 50 to $3.

Altitude	1,200 feet.
Length of ore shoot	120 feet.
Length of ore shaft on incline	40 feet.
Vertical depth reached in mine	90 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Safety Nitro.
Character of ore	Free milling quartz.
Character of works	Water power mill.
Number of stamps	5
Weight of stamp	650 pounds.
Drop of stamps	5 inches.
Drops	85 per minute.
Duty of stamp	1½ tons in twenty-four hours.
Kind of shoes and dies	Iron.
Size and character of screens	Brass wire, No. 50.
Water used in battery	1 miner's inch.
Dimensions of apron	8 by 4 feet.
Width of sluice	14 inches.
Length of sluice	15 feet.
Cost of milling	60 cents per ton.
Number of men in mill	2
Number of men in mine	2
Total number employed	4
Average wages in mine	$2 50 to $3 per day.
Average wages in mill	2 50 to $3 per day.
Head of water used for power	120 feet.
Quantity of water used for power	29 inches.
Cost of water for milling and for power	30 inches, at 8 cents per day, $2 40.

EXPERIMENTAL GULCH MINE.

This mine is situated in Experimental Gulch, one and one quarter miles northeast of Columbia. The course of the vein is about north and south,

and the dip east at an angle of about 45 degrees. The width of the vein is from three to four feet; the claim is one thousand five hundred feet in length by six hundred in width. The north ore shoot is about six hundred feet long and the south ore shoot about three hundred. The mine is situated on one of the sloping sides of the gulch and dips with the hill. Near the bottom of the gulch a vertical shaft has been sunk for fifty feet; on the side hill three tunnels have been driven, one of them one hundred and twenty-five feet in length. Above one of the tunnels on the ledge there are about four hundred feet of stoping ground, measuring on an incline of 45 degrees. The hanging-wall is magnesian limestone, and the foot-wall a dioritic rock. Fifty pounds of powder, Hercules No. 2, are required per month to break sufficient rock for treatment in the mill. The cost of mining is about 90 cents per ton. About one fifth of the excavations of the mine requires to be timbered, yellow pine being used; the logs sixteen feet long are from six inches to ten inches in diameter at the smaller end, and cost 64 cents delivered. Timber is conveniently at hand and everything admirably situated for cheap mining.

The ore is free milling though containing a small quantity of sulphurets, presumably insufficient to cause the adoption of any method for their recovery. The ore is treated by the free gold amalgamation process in a ten-stamp mill, provided with a Blanding rock crusher; each stamp weighs six hundred and fifty pounds, and drops five and one half inches ninety times per minute, crushing two and one half tons per stamp in twenty-four hours. The shoes and dies are of white iron and cost 5½ cents per pound, and last about eighty days. The estimated amount of water used in the batteries is three inches. The screens, Nos. 5 and 6 angle slot, are seven by forty-nine inches inside of a vertically arranged frame; the size of the apron is forty-six inches by ten feet, copper plates not silvered being used. Each battery is provided with a Challenge feeder. There are seven men, including the foreman, in the mine, three in the mill, and one on outside work; $2 75 are the daily wages paid in the mine; $3 50, $3, and $2 in the mill, and $2 per day for outside work. The mill is driven by a Pelton wheel four and one half feet in diameter under eighty feet of pressure, requiring forty-seven miner's inches of water, costing 10 cents per inch. The cost of milling per ton: Labor, 34 cents; water, 20 cents; quicksilver and screens, 2 cents; shoes and dies, 6 cents; other incidentals, 8 cents; total, 70 cents.

Length of ore shoots	One, 600 feet; the other, 300 feet.
Depth of ore shaft vertically	50 feet.
Character of hanging-wall	Limestone.
Character of foot-wall	Diorite.
Kind of powder used	Hercules, No. 2.
Quantity of powder used	50 pounds monthly.
Cost of mining	90 cents per ton.
Number of feet timbered	About one fifth of tunnels and shaft.
Kind of timber	Yellow pine.
Cost of timber	Round, 64 cents for stick 16 feet long, all sizes from 6-inch to 10-inch at smaller end.
Character of ore	Free milling gold quartz.
Character of works	Water power gold mill.
Number of stamps	10
Weight of stamps	650 pounds each.
Drop of stamps	4½ inches.
Drops	90 per minute..
Duty of stamp	2½ tons in twenty-four hours.
Kind of shoes and dies	White iron.
Size and character of screens	Nos. 5 and 6, angle slot.
Dimensions of apron	46 by 120 inches.
Length of sluice	10 feet.
Kind of feeder	Challenge.

Cost of milling	70 cents per ton.
Number of men in mill	Including foreman, 3.
Number of men in mine	Including foreman, 7.
Number of men on outside work	1
Total number employed	Including Superintendent, 12.
Average wages in mine	$2 75 per day.
Average wages in mill	$2 83⅓ per day.
Average wages paid outside work	$2 per day.
Quantity of water used in milling	3 inches.
Head of water used for power	80 feet.
Quantity of water used for power	47 miner's inches.
Cost of water for milling	3 inches, at 10 cents per inch, 30 cents.
Cost of water for power	47 inches, at 10 cents per inch, $4 70.

THE APP MINE.

This mine was located in 1856, and is situated in Quartz Mountain, a little over one mile southeast of Jamestown. The course of the vein is north about 28 degrees west; the dip is easterly about 69 degrees. The width of vein is from five to six feet. The claim is nine hundred and eighty-nine feet in length, and two hundred and ten to two hundred and thirty feet in width. There are two shoots of ore in the mine, one is from one hundred and forty to one hundred and fifty feet in length, and the other is two hundred feet. The mine is opened by a tunnel, running on the vein four hundred and fifty feet to the intersection of the shaft, about ninety feet perpendicular below the surface. The shaft is an incline about seven hundred and seventy-eight feet deep, with an angle of inclination of about 69 degrees, reaching a vertical depth of about seven hundred and thirty-five feet. The hanging-wall is gray greenstone (diorite), and the foot-wall black slate, with six inches to one foot of black gouge. The mine is comparatively a dry mine, the water being chiefly from the surface, not entering below the first one hundred and thirty feet. When the mine was first opened a Cornish pump was used, but was discontinued after a depth of one hundred and thirty feet was reached, and its place was not supplied by even the water barrel. Forty pounds of Giant powder No. 2 are consumed monthly. Though the tunnel and shaft are both in vein matter, on account of the nature of the ground no timbering was ever required. It is stated on the authority of Mr. App, one of the owners, that the ore for twelve years averaged $14 per ton. The ore is treated by amalgamation in the battery and on outside plates. The mill is driven by water power applied to an overshot wheel, sixteen feet in diameter, with three and one half-foot face. Water for power has not been measured, but it costs, together with that used in the battery, $1 per day. The mill contains five stamps, weighing six hundred and twenty-five pounds each, dropping four and one half to six inches seventy-five times per minute, crushing from one to two tons of ore per stamp in twenty-four hours. White iron from the Sonora foundry is used for shoes and dies, at a cost of 5 cents per pound, and the average duration of a set is ninety days. The battery requires about an inch of water. The screens are brass wire, forty and fifty meshes to the inch, and are placed vertically; their discharging surface is six inches by forty-four. The size of the apron is forty-four inches by sixteen inches. The smaller sluice, connecting the apron with the longer sluice, is sixteen inches wide and five feet long; the larger sluice is thirty inches wide and eighteen feet long, giving a total length of copper plates twenty-four feet four inches. The apron has a grade of one half inch to one foot (just enough for the pulp to flow off the plate), the balance of the sluice inclines one inch to one foot. The size of the mortar at the bottom is eleven inches by forty-eight, the perpendicular height of the lip above the

bottom being twelve inches. The mill is provided with a Stanford feeder. The recovery of gold inside of the battery amounts to from 50 to 80 per cent, according to the coarseness of the gold, the balance being caught on the outside plates. Two men are employed in the mine and two in the mill, at $3 per day each. It is in contemplation to procure a Pelton wheel for driving the machinery, and to add five stamps more to the mill. The present mill runs periodically on ores of this mine found near the surface.

Length of ore shoots	One, 140 feet; other, 200 feet.
Length of ore shaft on incline	778 feet.
Vertical depth reached in mine	735 feet.
Character of hanging-wall	Diorite (greenstone).
Character of foot-wall	Black slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used per month	40 pounds.
Cost of transport of ore	40 cents per ton.
Character of ore	Free milling quartz and slate.
Character of works	Water power free gold mill.
Number of stamps	5
Weight of stamps	625 pounds each.
Drop of stamps	4½ to 6 inches.
Drops	75 per minute.
Duty of stamp	1 to 2 tons in twenty-four hours.
Kind of shoes and dies	Sonora Foundry white iron.
Size and character of screens	Brass wire, Nos. 40 and 50.
Dimensions of apron	44 inches by 16 inches.
Widths of sluice	16 and 30 inches.
Lengths of sluice	5 feet of sluice 16 inches wide, 18 feet of sluice 30 inches wide.
Kind of feeder	Stanford.
Percentage of gold recovered saved in battery	Varies from 50 to 80.
Percentage of gold recovered saved on plates	Varies from 50 to 20
Cost of milling	50 cents to $1 per ton.
Number of men in mill	2
Number of men in mine	2
Total number employed	4
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Quantity of water used in milling	1 inch, approximately.
Cost of water for milling and for power	$1 per day.

THE HESLEP QUARTZ GOLD MINING COMPANY.

The Heslep Mine has been owned by the present company about twelve years. It was located over thirty years ago. It is situated in the Jamestown Mining District, about one and one half miles southwest of Jamestown. The course of the vein is northwest and southeast, and the dip is easterly. From the surface to four hundred feet deep the angle with the horizon is 80 degrees. From four hundred to five hundred feet in depth the inclination is about 60 degrees. The average width is about twenty feet. The size of the claim is fifteen hundred feet in length, and one hundred and fifty feet each side of the lode line. There is no regularity in the ore shoot, and its length has never been ascertained. The mine is worked through a shaft, which is vertical for one hundred and fifteen feet, and dips slightly for three hundred and eighty-five more, reaching a vertical depth of nearly five hundred feet. The hanging-wall is slate, and the foot-wall gray greenstone (diorite). The mine is what is called a "dry mine," making an inconsiderable quantity of water, hence requiring no pump or other appliance for raising water. No. 1 Giant powder is used as a blasting agent, but in very variable amounts, owing to the extreme irregularity in the condition of the ground worked. The cost of mining averages $2 per ton, and the cost of sinking the shaft (in size five by eleven feet) was $29 per foot, five feet of progress in sinking having been made per week. The first hundred feet of the shaft passed through slate, and the rest through vein matter. Timber was required only in the

vertical portion, the material used consisting of sawed yellow pine, purchased at a cost of $20 per thousand. The ore is free milling quartz, associated with slate-bearing pyrites, and is worked by the free gold process, in an ordinary water power stamp mill, driven by a fifty-foot overshot wheel, having a six-foot face. The mill contains a Blake rock breaker, ten by sixteen inches in size, twenty-five eight hundred and fifty-pound stamps, dropping five inches, with a nominal speed (though variable) of ninety times per minute, crushing one and one quarter tons per stamp, on the average, in twenty-four hours. White iron shoes and dies are used, costing 5¼ cents per pound. The shoes last about ninety days, and the dies about sixty—equivalent to a wear of one and fifteen one hundredths pounds of iron of the shoes per ton of ore crushed, and one and six tenths pounds of iron of dies, or 6 cents for shoes and 8.4 cents for the dies to the ton of ore crushed. About twelve inches of water are used in the batteries, which are furnished with brass wire screens, No. 50, slightly inclining from the perpendicular, with a discharging surface of ten inches by forty-four. The screen frames are so constructed as to leave a space on top opening into the batteries. The plates, which are silvered, are: aprons forty-four by forty-eight inches in size, and the sluices twenty inches in width by thirty-two feet in length. The batteries are supplied with both front and back plates, having dimensions of four feet by six inches, and inclined at an angle of 45 degrees. These plates are not removed during the run. The aprons and sluices have an inclination of about one inch to the foot. Two Hendy and three Stanford feeders are employed. Two thirds of the value which is recovered is found inside of the battery, and one third on the outside plates. The rock contains 5 per cent of iron pyrites, assaying about $20 per ton in gold, and consequently no effort is made for recovery of sulphurets. The number of men employed in the mine is seven, in the mill five, on outside work four; total sixteen. Miners are paid $2 50 to $3 per day; from $2 to $3 50 are paid the mill men, and those engaged on outside work receive from $2 to $3. Twelve cords of oak wood are used per month. The batteries and overshot wheel require two hundred and seventy-five miner's inches of water in twenty-four hours, for which 3⅓ cents per inch is charged, or $9 17 per day. The hoisting works are run by steam.

The developments on the mine consist of levels running from every one hundred feet in the shaft. The cost of milling: Labor, 40 cents; shoes, 6 cents; dies, 8 cents; quicksilver, screens, oils, etc., 2 cents; water, 29 cents; total, 85 cents.

Depth of ore shaft	Vertically, 115 feet; on incline, 385 feet.
Vertical depth reached in mine	Nearly 500 feet.
Character of hanging-wall	Slate.
Character of foot-wall	Diorite (greenstone).
Kind of powder used	Giant, No. 1.
Cost of mining	$2 per ton.
Cost of shaft (excavation 5 by 11 feet)	$29 per foot.
Number of feet timbered (vertical portion of shaft)	115
Kind of timber	Sawed yellow pine.
Cost of timber	$20 per thousand.
Character of ore	Quartz and slate, free milling.
Character of works	Water power stamp mill.
Number of stamps	25
Weight of stamps (average)	850 pounds each.
Drop of stamps	5 inches.
Drops (variable—intended)	90 per minute.
Duty of stamp	1¼ tons in twenty-four hours.
Kind of shoes and dies	White iron (from Sonora Foundry).
Size and character of screens	Brass wire, No. 50.
Water used in battery	12 miner's inches.
Dimensions of apron	44 by 48 inches.

Width of sluice	20 inches.
Length of sluice	32 feet.
Kind of feeders	2 Hendy, 3 Stanford.
Percentage of gold saved in battery	66⅔
Percentage of gold saved on plates	33⅓
Percentage of sulphurets	5
Value of sulphurets	$20 per ton.
Cost of milling	$0 85 per ton.
Number of men in mill	5
Number of men in mine	7
Number of men engaged in outside work	4
Total number employed	16
Average wages in mine	$2 50 to $3 per day.
Average wages in mill	$2 to $3 50 per day.
Average wages paid outside work per day	2 engineers at $3 50 each, 2 bucket tenders at $2.
Wood used	¾ cord per day.
Cost of wood	$5 50 per cord.
Quantity of water used in milling	12 miner's inches.
Quantity of water used for power	263 miner's inches.
Cost of water for milling and for power	3⅓ cents per inch per day—$9 16⅔

THE GEM MINE.

This mine, located in 1878, is situated in the Jamestown Mining District, one mile west of Jamestown. The course of the vein is northwest and southeast, and the direction of dip easterly, at an angle of 45 to 50 degrees, and the width is about six feet. The claim is five hundred and fifty feet in length and six hundred in width; one hundred feet of the ground lying west of the lode line, and five hundred feet lying on the east side. The length of the ore shoot, as far as determined by development, is five hundred feet. The mine is opened by a tunnel, reaching a vertical depth from the surface of seventy feet, and by a shaft one hundred and seventy-five feet deep, and an incline extending about eighty-five feet below the tunnel, the incline being nearly perpendicular. The hanging and foot-walls are slate. Considerable surface water comes in the mine, according to the season of the year; the amount, however, has not been determined, and no pump is used. Very little powder is required, that used being Giant and Vulcan. Mining costs from $1 to $2 per ton. The cost of the tunnel is estimated at $6 per foot. The size of the shaft is five by six feet, and sinking, which was in vein matter and gouge, progressed at the rate of from four to five feet per day. The shaft is timbered from top to bottom with sawed yellow pine, costing $20 per thousand. One half mile of road and three quarters of a mile of ditch were constructed at the mine. The ore is free milling quartz, containing some sulphurets; no attention being paid to any but free gold values. The ore is treated by the usual amalgamation process in a ten-stamp mill, containing neither concentrators, blankets, nor riffle sluice, nor other sulphuret-recovering appliance. The gold recovery is by amalgamation in the battery and on outside plates. The mill, which is driven by an overshot wheel thirty-two feet in diameter, is not equipped with an ore crusher. The stamps, which weigh six hundred and fifty pounds each, drop from four to seven inches seventy to one hundred times per minute, crushing about one ton of ore per stamp in twenty-four hours. Iron from the Sonora foundry is used for shoes and dies, costing, delivered, about 5½ cents per pound. A set of shoes and dies lasts about eight weeks; the shoes weighing about one hundred and twenty-five pounds each, and the dies eighty-five; two and twenty-three one hundredths pounds of iron will represent the wear of the shoes per ton of ore crushed, and one and fifty-two one hundredths pounds will represent that of the dies, or expressed in expense of working the ore per ton, 12 cents for shoes and 8 cents for dies. The batteries, using about six miner's inches of water, are usually

provided with No. 50 brass wire screens, their dimensions inside of the frame being about eight inches by four feet, inclination being 20 degrees from the vertical; the aprons are three by four feet; the sluice two feet wide and sixteen feet long. Both front and back plates are used in the battery, six and one half inches by forty-eight, and somewhat inclined; the outside plates are silvered and have an inclination of one half inch to one foot. Tullock ore feeders are used. Six men are employed in the mine, two men in the mill, eight men in all. The wages are the same in the mine and mill, $3 per day. Sixty inches of water are used at a cost of 10 cents per inch for twenty-four hours. The cost of milling per ton: Labor, 60 cents; water, 60 cents; shoes, 12 cents; dies, 8 cents; quicksilver, screens, oil, lights, incidentals, 5 cents; total, $1 45.

Altitude (aneroid reading)	1,500 feet.
Length of ore shoot	500+ feet.
Length of ore shaft on incline	175 feet.
Vertical depth reached in mine	150 feet.
Character of both walls	Slate.
Kind of powder used	Giant and Vulcan.
Cost of mining	$1 to $2 per ton.
Cost of tunnel	$6 per foot.
Number of feet timbered	All.
Kind of timber	Sawed yellow pine.
Cost of timber	$20 per thousand feet.
Length of road built	One half mile.
Length of ditch built	Three fourths of a mile.
Character of ore	Free milling quartz.
Character of works	Water power stamp mill.
Number of stamps	10
Weight of stamps	650 pounds each.
Drop of stamps	4 to 7 inches.
Drops	70 to 100 per minute.
Duty of stamp	1 ton in twenty-four hours.
Kind of shoes and dies	Sonora Foundry iron.
Size and character of screens	Brass wire, No. 50.
Water used in battery	6 inches.
Dimensions of apron	3 by 4 feet.
Length of sluice	2 feet.
Kind of feeder	Tullock.
Cost of milling	$1 45 per ton.
Number of men in mill	2
Number of men in mine	6
Total number employed	8
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Quantity of water used in milling	6 miner's inches.
Quantity of water used for power	54 miner's inches.
Cost of water for milling and for power	60 inches, at 10 cents per inch per day, $6.

THE SEEBER MINE.

This property is situated on the mother lode near Jamestown. The ore is worked in a fifteen-stamp mill driven by water power; the stamps weigh seven hundred and fifty pounds each, and crush about forty tons per day through a brass wire thirty-mesh screen, the drop of the stamp being about six inches and the rate of speed about ninety times per minute. The mill is supplied with the Seeber feeders and a rock breaker, but no concentrators; the ore is treated by the ordinary amalgamation process in use with free milling gold ores. The yield for the last year is stated to have been $150 per ton.

THE CONSOLIDATED EUREKA.

This property, embracing the Eureka and Dead Horse Mines, is situated one quarter of a mile southeast of Summersville. The mines were discovered in about 1858. The principal developments consist of a shaft seven

hundred feet deep on Dead Horse ground, with five levels. The country rock is slate. The work has been performed by contract, and the hoisting machinery has been driven by steam power, until within a few months, when extensive improvements were made by the introduction of water power, by constructing about nine miles of ditch and laying several hundred feet of twelve-inch pipe, whereby a pressure of about six hundred and eight feet was secured. There has also been constructed a twenty-stamp water power mill, the stamps weighing seven hundred and fifty pounds each. The mill contains, also, eight Frue concentrators and all the modern improvements. Two lines of pipe are laid, one for the mill and air compressor, and the other for the hoisting works. The ore is said to contain 2 per cent of sulphurets.

THE NEW ALBANY.

This property is situated on the Tuolumne River, about a mile from Summersville. The vein is about three feet in width, and the mine is opened by a tunnel. Below the level of the tunnel a shaft has been sunk to a depth of about eight hundred feet; from the bottom of the shaft a level is driven south over six hundred feet. The formation of the country rock is slate. The mine is connected by tramway with a ten-stamp free gold mill, driven by water power. This property has laid idle for several years, but arrangements have now been made to resume mining and reduction.

THE BLACK OAK MINE.

This mine was located September, 1878, and is situated in the Tuolumne Mining District, about one mile northwest of Soulsbyville. The course of the vein is north 12 degrees east, and the dip westerly at an angle of 17 degrees; the average width is two feet. It is a full claim, fifteen hundred feet in length by six hundred feet in width, and is worked by an incline shaft two hundred feet deep; both walls are granite. The water is removed from the mine by two four-inch pumps, with four-foot strokes, and eight strokes per minute, the pumps being "jackhead" and plunge combined. About five hundred pounds of dynamite are used monthly. The formation passed through is granite, and the entire shaft is timbered with pine timber costing $18 per thousand, being hauled twelve miles. The company has built a little over one half a mile of wagon road, and connected their mine and mill by a tramway. The mill contains ten stamps, weighing eight hundred and fifty pounds each, dropping five and one half inches ninety times per minute, the duty of the stamp being three quarters of a ton in twenty-four hours. Steel shoes and dies are used, costing 9 cents per pound. The screens are No. 50 brass wire, the dimensions of which inside of the frame are nine inches by four feet, and are very slightly inclined from the perpendicular; the aprons are four feet by fourteen feet in dimensions, covered with electroplate, with a grade of three inches to one foot; the mortars are furnished with front and back inside plates, the front plates being five inches wide and the back nine inches wide. Hendy Challenge feeders and four Frue vanners are employed. The ore contains about 3 per cent of sulphurets, composed of iron, copper, and lead, mechanically associated; the sulphurets are recovered on Frue vanners and on Morris canvas tables, and sold. The number of men employed in the mine is thirty-six, in the mill, twelve, and on outside work, eight; total, fifty-six. The average wages paid per day, in the mine, is $3, in the mill, $2 75, and on outside work, $3. Four and one half cords of pine wood, costing $3 50 per cord, are consumed daily at mine and mill. The pumps

are driven by a twenty-foot overshot wheel and require for power sixty miner's inches of water per day (measuring through a six-inch opening with a four-inch head), at a cost of 12½ cents per inch.

Length of ore shaft on incline	200 feet.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Kind of powder used	Dynamite.
Quantity of powder used	500 pounds per month.
Number of feet timbered	200
Kind of timber	Pine.
Cost of timber	$18 per thousand feet.
Length of road built	One half mile.
Character of ore	Sulphureted quartz, free milling.
Character of works	Steam stamp mill and concentrators.
Number of stamps	10
Weight of stamp	850 pounds.
Drop of stamps	5½ inches.
Drops	90 per minute.
Duty of stamp	Three quarters of a ton in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Brass wire, 50 meshes to one inch.
Dimensions of apron	4 by 14 feet.
Kind of feeder	Challenge.
Kind of concentrators	Frue.
Percentage of sulphurets	3
Number of men in mill	12
Number of men in mine	36
Number of men engaged in outside work	8
Total number employed	56
Average wages in mine	$3 per day.
Average wages in mill	$2 75 per day.
Average wages paid outside work	$3 per day.
Wood used	4½ cords per day.
Cost of wood	$3 50 per cord.
Quantity of water used for power	60 miner's inches.
Cost of water	12½ cents per miner's inch.

THE PLATT AND GILSON MINE.

This mine is situated in the town of Soulsbyville, and was located in 1856. The course of the vein is north and south, the dip being nearly vertical, and the average width is about eighteen inches. The length of the claim is two thousand two hundred and fifty feet, but the length of the ore shoot is undetermined. The mine is opened by both shaft and tunnel, the latter being four hundred feet in length, reaching a vertical depth of ninety feet from the surface; the shaft is about vertical and one hundred and forty feet deep, and both of the walls are granite.* The water is removed by a four-inch jackhead pump, with a four-foot stroke, running ten strokes per minute. The cost of sinking the shaft is $20 per foot, and it was sunk at the rate of about one foot per day, the formation passed through being granite. About ninety feet of the shaft are timbered, yellow pine having been used, costing about $18 per thousand. The lumber is hauled about twelve miles. The company has constructed about three quarters of a mile of ditch. The ore is quartz, more or less heavily sulphuretted, and the method of treatment is by amalgamation in a stamp mill.

THE BUCHANAN MINE.

This mine was located about thirty years ago, and is situated in the Buchanan Mining District, eight miles east of Summersville, and twenty-eight miles east of Sonora, by the road, and about fourteen miles by the

*Since the notes above written were taken, the shaft has reached a depth of two hundred feet, and new machinery for pumping and hoisting has been introduced.

trail. The course of the vein is east and west, and the dip south at an angle of 43 degrees, the width being eight feet. The claim is of full size, one thousand five hundred feet in length by six hundred feet in width, the length of the ore shoot being three hundred feet. The mine is worked by a tunnel and two shafts, the tunnel being three hundred and twenty-five feet in length, reaching a vertical depth of one hundred and ten feet below the surface. Of the two incline shafts, one extends from the surface to the five hundred-foot level; the other starts from the five hundred-foot level, at a point three hundred feet east of the first mentioned shaft, and is sunk two hundred feet. The formation of the walls is slate. About fifty thousand gallons of water come into the mine daily from the third and fourth levels; below these levels there is no inflow of water worth mentioning. At the two hundred station a Garrett steam pump No. 2, having an inch and a half column, raises the water to the surface; a Worthington duplex action six by twelve-inch pump, with an inch and a half column and three-inch suction pipe, raises the water from the four hundred to the two hundred level. The Rix compressor and National drill are employed, and four thousand pounds of Hercules powder, No. 2, are consumed per month, and sixty feet of three quarter-inch octagonal Black Diamond steel. Mining costs $3 per ton; running levels, $6 per foot, one foot being an average progress per day; the average cost of sinking the inclines is $30 per foot, the excavation made being seven feet by twelve, and the size in the clear, five by nine feet; the average progress of sinking is one foot per day; the formation passed through, slate and ore. In the incline, sawed yellow pine is employed from the surface four hundred feet, the last one hundred feet not requiring timber; from the five hundred to the six hundred level timber of the same kind is employed; the balance of the incline, being in hard ground, is not timbered; the tunnel is timbered the whole length. Sawed lumber costs $25 per thousand; in the case of round timber, 1¾ cents is paid per foot for peeling the whole tree; adding the hauling, the total cost is about 4½ cents per foot; the timber being all about the mine, the hauling is usually less than two miles.

Fourteen miles of road were built by the company and five miles of lumber flume constructed. The ore is transported to the works by automatic cars, which are supervised by one man at an expense of $65 per month. The ore is free milling quartz, both hard and soft, containing sulphurets; it is treated by amalgamation process. The mill, which is furnished with a Blake crusher (large size) and steel cams and tappets, is driven by steam power, the engine employed being twelve by eighteen, and the boiler fifty-four inches in diameter and sixteen feet long, supplied with a heater and a No. 2 Garrett feed pump. The mill contains twenty stamps, weighing eight hundred and fifty pounds each, which drop seven inches ninety times a minute, and crush on the average one and one half tons of ore per stamp in twenty-four hours. For shoes and dies, iron is used from the Sonora Foundry, chrome steel from the Adamantine Steel Works, and steel from San Francisco. Sonora iron lasts on the average five weeks, and costs 5½ cents per pound; Adamantine steel lasts three months; San Francisco steel lasts three months—steel costing 9 cents per pound. The statement of the Superintendent is that the steel used in this mill has a tendency to form "bug holes." According to the experience of different Superintendents, with different ores, there seems to be a wide variance in the comparative wear of iron and steel and resulting cost per ton of ore crushed. According to experience here, an iron shoe and die, weighing about two hundred and forty pounds, crushes fifty-two and one half tons of ore, or four and thirty-eight hundredths pounds of iron are consumed in crushing

one ton of ore. Iron being 5½ cents per pound, the cost of iron consumed in crushing a ton of ore would be 24 cents. The steel shoe and die, weighing about 8 per cent more than the iron, or about two hundred and sixty pounds, are worn out in crushing about one hundred and thirty-five tons of ore, about one and ninety-two hundredths pounds of steel to the ton of ore crushed; at 9 cents per pound for steel, the cost of the steel consumed in crushing a ton of ore is about 17 cents. Six to seven miner's inches of water are used in the battery and on the concentrators, about one and one half inches being used on the latter (the measurement being four inches above the top of a three-inch slot in a two-inch plank). The battery screens are brass wire, forty meshes to one inch, placed vertically, and have a discharging surface of ten inches by forty-four. The plates are ten feet long and forty-four inches wide on the apron, and on the sluice eighteen inches wide and sixteen feet long, and are silvered; the aprons have an inclination of one inch to one foot and the sluices four inches in sixteen feet. The mortars are provided with front and back plates, six inches wide and forty-two inches long, inclined 20 degrees from the horizontal. Challenge feeders are employed. Two thirds of the recovery of free gold is made in the battery and one third on the outside plates. There are eight Frue concentrators in use, saving about 1½ per cent of sulphurets, principally iron pyrites, associated with a little galena and chalcopyrite, having a value of from $100 to $250 per ton. Three blanket sluices, side by side, forty feet long, are used below the Frue vanners to assist in the recovery of the sulphurets. Thus far the concentrations have been stored; it is stated that three hundred and fifty tons are on hand to be reduced by the Plattner process, after chlorination works have been erected by the company.*

Thirty-five men are employed in the mine, exclusive of two engineers, two carmen, two blacksmiths, two carpenters, and one compressor man; six men are employed in the mill; aggregating, with the Superintendent and foreman and those making brick for the contemplated roasting furnace, about sixty men. Miners receive $3 per day; three men on the drill, $3 50; engineers, $3; amalgamators, $3 50; rock breaker men, $2 50; others engaged in outside labor, $40 per month and board. Ten cords of yellow pine wood, costing $3 per cord, are used at the mine and mill. The machinery at the hoisting works consists of two steel boilers, fifty-four inches in diameter and sixteen feet long; one engine with ten-inch cylinder and eighteen-inch stroke; friction gear drums, four feet four inches in diameter; steel wire cable, three fourths of an inch in diameter; and bucket holding eight hundred and fifty pounds of ore; and on the five hundred-foot level, at the lower incline, two engines eight by twelve, and a self-dumping skip, holding one ton, are employed.

The developments, besides the tunnel and two inclines, consist of levels every one hundred feet from top to bottom, and a twelve-foot sump below the five hundred-foot level. There are no stations in the hanging-wall, but there are shoots in each level about twenty-five feet distant from each other. During the present year the incline has been sunk one hundred feet, the six hundred level has been run west seventy-four feet, and another shoot has been discovered thirty feet from the main ledge; in the hanging-wall drifts have been run thirty feet each way in the ore, which is of good grade; uprises have been made from the six hundred to the five hundred level, and from the three hundred to the two hundred. It is proposed to put in an air compressor on the Middle Fork of the Tuolumne River, one

*Since the above notes were taken the company has erected chlorination works on the plan of the Amador Reduction Works at Sutter Creek.

and one half miles from the mine, and drive the mill and mine by compressed air (three hundred horse power being required for the purpose); all of the machinery to be driven in this manner, including pumps and drills. It is also proposed to continue sinking to one thousand feet in depth.

Altitude (aneroid reading)	3,200 feet.
Length of ore shoot	300 feet.
Length of ore shaft on incline from surface	500 feet.
Length of ore shaft on incline from 500-level, 300 feet east	200 feet.
Vertical depth reached in mine	550 feet.
Quantity of water raised in twenty-four hours	50,000 gallons.
Character of walls	Slate.
Kind of powder used	Hercules, No. 2.
Quantity of powder used	4,000 pounds per month.
Cost of mining	$3 per ton.
Cost of tunnel	$6 per foot.
Cost of shaft	$30 per foot.
Number of feet timbered	Tunnel and shafts, 1,025; levels, 1,200.
Kind of timber	Yellow pine.
Cost of timber	For round timber, 4½ cents per running foot; sawed, $25 per thousand.
Length of road built	14 miles.
Length of ditch (lumber flume) built	5 miles.
Cost of transport of ore	$65 per month.
Character of ore	Free milling gold ore.
Character of works	Steam power wet crushing mill.
Number of stamps	20
Weight of stamp	850 pounds.
Drop of stamps	7 inches.
Drops of stamp	90 per minute.
Duty of stamp	1½ tons in twenty-four hours.
Height of discharge when dies are new	4 inches.
Kind of shoes and dies	Usually iron; have tried different kinds of steel.
Size and character of screens	No. 40, brass wire.
Dimensions of apron	10 by 44 inches.
Width of sluice	18 inches.
Length of sluice	16 feet.
Kind of feeder	Challenge.
Kind of concentrators	Frue.
Percentage of gold recovery saved in battery	66⅔
Percentage of gold recovery saved on plates	33⅓
Percentage of sulphurets	1½
Value of sulphurets	$100 to $250 per ton.
Cost of milling	$1 25 per ton.
Number of men in mill	6
Number of men in mine	35
Total number employed	60
Average wages in mine	$3 per day.
Averages wages in mill	$3 25 per day.
Average wages paid outside work	$40 per month.
Wood used	10 cords per day.
Cost of wood	$3 per cord.
Quantity of water used in milling	6 to 7 miner's inches.

THE KANAKA MINE.

This mine is situated in the Gravel Range Mining District, about five miles distant, in an easterly direction from the town of Groveland. The vein is in a slate formation, and has a southeasterly and northwesterly course, and dips northeasterly at an angle of about 30 degrees, and has an average width of about two feet. The property embraces the mining claim, fifteen hundred feet in length and six hundred feet in width, and one hundred and sixty acres of timber land adjoining. There are three ore shoots, one hundred and fifty, one hundred and seventy-five, and three hundred feet in length, respectively. The mine is worked through four different tunnels running on the vein, the longest, five hundred feet in length, the shortest, two hundred. The vertical depth reached in the mine is about

four hundred and fifty feet. The improvements consist of a five-stamp mill, driven by water power, each stamp weighing seven hundred and fifty pounds, and dropping six inches at the rate of ninety times per minute, crushing one and one quarter tons of ore per diem. Seventy-five per cent of the recovery is in the battery and 25 per cent from the outside plates; the sulphurets, amounting to about 2 per cent of the ore, have an assay value of about $75 per ton.

Altitude (aneroid reading)	2,230 feet.
Length of ore shoots	First, 175 feet; second, 150 feet; third, 300 feet.
Vertical depth reached in mine	450 feet.
Character of both walls	Slate.
Kind of powder used	Giant, No. 2.
Cost of mining	$1 per ton.
Cost of tunnel	$3 50 per foot.
Kind of timber	Pine.
Cost of timber	2 cents per running foot.
Length of road built	2½ miles.
Length of ditch built	One half mile.
Character of ore	Free milling.
Character of works	Water power stamp mill.
Number of stamps	4
Weight of stamp	750 pounds each.
Drop of stamps	6 inches.
Drops	90 per minute.
Duty of stamp	1¼ tons in twenty-four hours.
Kind of shoes and dies	Steel.
Size and character of screens	Slot, size corresponding to 40-mesh.
Water used in battery	1½ miner's inches.
Dimensions of apron	4 by 10 feet.
Width of sluice	20 inches.
Length of sluice	11 feet.
Kind of feeder	Seeber's, of Sonora.
Percentage of gold recovery saved in battery	75
Percentage of gold recovery saved on plates	25
Percentage of sulphurets	2
Value of sulphurets	$75 per ton.
Cost of milling	$1 (the labor amounts to 80 cents) per ton.
Number of men in mill	2
Number of men in mine	5
Total number employed	7
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Quantity of water used in milling	1½ miner's inches.
Head of water used for power	260 feet.
Quantity of water used for power	15 miner's inches.

THE GOLDEN TREASURE MINE.

This mine is situated on the Hyde ranch, and not in an organized mining district. It is three miles northwest of Soulsbyville, the nearest town, and about eight miles east of Sonora. The course of the vein is about north 30 degrees west, and the direction of the dip easterly at an angle of from 38 to 40 degrees; the width varies from four to twenty-six feet; the pitch of the ore shoot is northerly. The claim is three hundred and twenty acres, covered by United States agricultural patent. The mine was discovered after the issuance of the patent. The main ore shoot has been explored for about four hundred and forty feet, that being the extreme length of levels north and south, both places being in ore, but some of the intervening ground is barren. Another parallel shoot has been discovered, but its length has not been determined.* The mine is worked through an incline shaft, three hundred and fifty feet deep, corresponding to a vertical depth of about two hundred and twenty-five feet, a drain tunnel about two

*This parallel shoot lies about one hundred and fifty feet west of the main one; width, one to two feet.

hundred and fifty feet long intersecting the shaft at ninety feet from the surface. The country rock is granite. It is estimated that about ninety thousand gallons of water come in the mine daily; it is raised by a six-inch Cornish jackhead pump. Hercules powder, No. 2, is employed as a blasting agent. The cost of the tunnel, which was driven at the rate of about four feet in twenty-four hours, was $2 25 per foot; vein matter was the material in which the shaft was sunk. The shaft is timbered with yellow pine for about two hundred and fifty feet, the timber growing about the mine and costing about 3 cents per running foot. There is no cost for ore transportation, the mine and mill being close together. The ore, which is free milling and contains sulphurets, is treated by amalgamation in a five-foot Huntington roller mill, which is provided with outside electroplates. The machinery is driven by a twelve-horse power engine, and besides the Huntington, consists of a Blanding crusher, nine by twelve, and two Victor concentrators. The apron and sluice are in one, being four feet wide and sixteen feet long, with an inclination of one and one quarter inches to one foot, but provided with vertical screws at the lower end that the grade may be changed at a moment's notice to adapt it to different ores. A Challenge feeder is connected with the mill.

According to the statement of the Superintendent, the wear of iron amounts to about 2½ cents per ton of ore crushed; two to three inches of water are used in the battery. The ore is crushed very fine before going to the Huntington, which treats from fifteen to twenty-five tons in twenty-four hours. Three angle slot screens, No. 8, are used; they are eight inches in width and two and one half feet high, and are arranged vertically. About nine tenths of the value of the amalgam is recovered inside of the Huntington mill, and about one tenth on the outside plates. On the concentrators about 2½ per cent of sulphurets are saved, but the Superintendent states that the tailings contain as large a percentage, which is not recovered. The sulphurets are iron pyrites, containing some arsenic and antimony, combined with some galena and copper pyrites, having a value, it is stated, of from $200 to $300 per ton in gold, and from $5 to $12 in silver; they are sold to the Selby Smelting and Lead Company at Vallejo Junction, with a charge of $20 per ton for treatment, the freight from the mine being very nearly the same amount; the return guaranteed being 85 per cent of the gold content.

At present six men are employed in the mine, four in the mill (two engineers and two millmen), and two are engaged on outside work. The average wages paid in the mine per day are $3, in the mill $3, and on outside work $2 50. Of wood, six cords of pine, manzanita, and oak, costing $2 per cord, are consumed in twenty-four hours; of this amount the mill requires one and one half cords, and the pump and hoisting works require four and one half cords. It is proposed to connect the main canal, two and one half miles distant, with the hoisting works and mill, by a line of pipe, and secure water for power for all the machinery, including a compressor and power drills to be introduced. It is said the pressure from the canal would be over one thousand two hundred feet. It is proposed also to sink a perpendicular four-compartment shaft, and erect new hoisting works suitable for carrying on the work on a more extended scale. The developments consist of three levels run on the main shoot of ore, one at one hundred feet, one at two hundred and twenty-five feet, and one at about three hundred and fifty feet from the surface; the lower level being about four hundred and forty feet long, and one hundred and twenty feet run on the west parallel ledge. The improvements, beside the hoisting works and mill, consists of seven cabins, including the office and boarding

and lodging houses, and a large two-story dwelling house and barn, and two hundred of the three hundred and twenty acres under fence and cultivation, and a fine orchard of five hundred fruit trees.

Altitude (aneroid reading)	2,740 feet.
Length of ore shoot	440 feet.
Length of ore shaft on incline	350 feet.
Vertical depth reached in mine	225 feet.
Vertical depth of water shaft	225 feet.
Quantity of water raised, estimated in twenty-four hours	90,000 gallons.
Character of hanging-wall	Granite.
Character of foot-wall	Granite.
Kind of power used	Hercules, No. 2.
Cost of tunnel	$2 25 per foot.
Number of feet timbered	200 in tunnel; 250 in shaft.
Kind of timber	Yellow pine.
Cost of timber	3 cents per running foot.
Character of ore	Free milling and sulphureted.
Character of works	Huntington mill, amalgamating, and concentrating.
Duty of Huntington mill	15 to 25 tons in twenty-four hours.
Size and character of screens	No. 8 angle slot.
Water used in battery, estimated	2 to 3 miner's inches.
Dimensions of apron	4 by 16 feet.
Kind of feeder	Challenge.
Kind of concentrators	Victor.
Percentage of gold recovery saved in Huntington mill	90
Percentage of gold recovery saved on plates	10
Percentage of sulphurets saved	2¼
Value of sulphurets	$200 to $300 per ton.
Cost of working sulphurets	$20 per ton.
Percentage of value allowed from sulphurets	85
Number of men in mill	4
Number of men in mine	6
Total number employed	2
Average wages in mine	$3 per day.
Average wages in mill	$3 per day.
Average wages paid outside work	$2 50 per day.
Wood used	6 cords per day.
Cost of wood	$2 per cord.

THE BELCHER CONSOLIDATED MINE.

This property is situated one and one half miles northwest of the town of Groveland, and consists of two parallel ledges, lying about two hundred feet apart, called the Defferari and Diamond, having an east and west course, and dip to the north at an angle of 40 degrees. The hanging and foot-walls of each are hard, black slate. The Defferari shaft is one hundred and twenty-seven feet deep. At sixty feet from the surface a level has been driven one hundred and eighty feet. At the east end an incline has been sunk forty feet, and a tunnel driven about eighty feet on the vein. A tunnel follows the vein on the Diamond for about six hundred feet, and is connected with the surface by a shaft fifty feet deep. For reducing the ore, which is free milling, there are employed a Blanding crusher, No. 2, with seven and one half by nine and one half inches of opening, and a Kendall oscillating mill, having a capacity of reducing from eight to twelve tons in twenty-four hours, with use of an ordinary sized screen, the machinery being driven by an eight by twelve-inch engine.

THE LONGFELLOW MINE.

This mine is situated in the Big Oak Flat Mining District, a short distance from the town of Big Oak Flat. It is said to be one of the first mines in which a so called "pocket" was discovered having any considerable magnitude. It is known solely as a "pocket mine." A shaft has been

sunk one hundred and thirty-five feet in depth, measured on the incline, and drifts have been run, the longest of which is one hundred and fifty feet easterly and one hundred and twenty-five feet westerly on the vein, and they are being extended. The method of reduction and recovery is the hand mortar and custom mill. The property was located in 1854, and from that time to the present there have been several successive owners, all of whom are said to have retired well recompensed.

Altitude (aneroid reading)	3,200 feet.
Length of ore shaft on incline	135 feet.
Vertical depth reached in mine	70 feet.
Quantity of water raised in twenty-four hours	10,000 gallons.
Character of hanging-wall	Slate.
Character of foot-wall	Slate.
Kind of powder used	Giant, No. 2.
Quantity of powder used	50 pounds per month.
Cost of mining	$2 per ton.
Cost of tunnel	$3 per foot.
Cost of shaft	$12 per foot.
Number of feet timbered	135
Kind of timber	Nut pine and yellow pine.
Cost of timber	7 to 8 cents per running foot.
Length of road built	1 mile.
Cost of transport of ore	50 cents per ton.
Character of ore	Free milling.
Character of works	Steam hoisting works and pump.
Number of men in mine	10
Total number employed	12
Average wages in mine	$3 per day.
Average wages paid outside work	$1 75 per day.
Wood used	2 cords per day.
Cost of wood	$3 50 per cord.

THE EMPIRE GRAVEL MINE.

This mine is situated in Table Mountain, in the Shaw Flat District, about three miles southeast of Columbia, and nearly four miles west of Sonora. The claim embraces seventy-five acres, surveyed to give about twenty-five hundred feet in length. The course of the channel is nearly north and south. This channel is reached by a tunnel eight hundred and thirty-one feet in length, having a grade of thirty-one feet in the whole length. The end of the tunnel, vertically measured, is two hundred and thirty-four feet below the surface. The cost of the tunnel was about $40 per foot, and it was driven eastward through block slate, standing with a dip to the east at an angle of about 60 degrees from the horizontal. Cemented blue gravel is the pay deposit of the channel, and the bedrock is block slate, dipping east 60 degrees with the horizon and pitching south six inches in one hundred feet. The depth of the gravel drifted varies from six inches to three feet; above it lies gray stratified volcanic sandrock, containing bowlders scattered here and there, and above this are about one hundred feet of lava, extending to the surface. About one third of the gold obtained is found extending into the bedrock seams or slate crevices from one to twelve inches when the rock is shelly. The inside measurement of the car is twenty-four inches by sixteen inches by fifty-two inches, giving a capacity, estimated at the mine, of seventeen hundred pounds of gravel, containing $4 to $16 per carload. During the inspection of the mine fourteen carloads of gravel yielded $74. According to the statement of the owners, the eight carloads previously cleaned up yielded $114. At present work is only performed by the owners until such a time as the mine is better opened. The gravel is washed in a sluice, and the tailings are saved to be rewashed after the cemented material has slacked for

about a year; it is said that there is yielded one quarter as much gold in this washing as on the first occasion.

The claim has been worked at intervals for over twenty years, but once lay idle for two years. The width of the channel varies, but here it is not definitely known; the drift is on the west shore, and from forty to sixty feet have been drifted eastward without reaching the east shore. Not a great deal of timbering is required, nothing usually but posts and caps about ten inches in diameter, and very rarely any lagging; the posts and caps at present are of either "bull pine" or black oak, which cost about 50 cents each, and are hauled from one to five miles. There are occasional heavy quartz bowlders, but no water to contend with. The developments from the tunnel are a drift on the gravel for five hundred and eighty feet in a southerly direction, and for three hundred and fifty feet north, ten feet above the tunnel level. The gold produced from this claim is said to be worth over $19 per ounce. The first claim on this channel north of the Empire Gravel Mine is now being prospected; it is called the Crystal Springs Gravel Mine, a description of which is given under the proper heading.

Altitude (aneroid reading)	1,900 feet.
Course of lead	North and south.
Length of tunnel	831 feet.
Depth of gravel below the surface	234 feet.
Cost of tunnel	$40 per foot.
Nature of pay dirt	Cemented blue gravel.
Nature of bedrock	Block slate.
Depth of gravel drifted	6 inches to 3 feet.
Capacity of car	1,700 pounds.
Pay per car (stated)	$4 to $16.
Length of time worked	20 years.

THE CRYSTAL SPRINGS GRAVEL MINE.

This mine, which was worked in early days, has laid idle until the past year. It yielded largely in precious metals until the overlying basalt settled and "broke-down" the mines in the immediate vicinity. Since then the expense of reopening the channel has deterred every one from the attempt until the present owners purchased the property. They are now driving a tunnel to drain the mine, and eventually propose to put in it a flume to convey the gravel, thereby saving two thousand feet of car transportation to the mouth of the tunnel, where the gravel is to be washed. In 1858 gravel that would not pay more than $4 per carload was left in the mine, $4 per carload being the lowest grade that would then pay expenses. The size of the claim is seventy acres, and the length of the tunnel being driven is three hundred feet.

Other claims on this channel south of the Empire Gravel Mine are the Down East, then the Boston, working five men on pay gravel, and the New York, working four men, also getting pay gravel. The Boston tunnel is from four hundred to five hundred feet in length. The New York works by an incline four hundred and fifty feet deep, and a drain tunnel two thousand two hundred feet in length. The general description of the Empire Gravel Mine heretofore given will suffice to illustrate the others in this section, all having a general character.

SHAW FLAT.

The blue gravel worked in these mines forms the bed of a large, tortuous, ancient stream, which had a general southerly course, winding through an

extensive valley, which lay in the course of the great lava flow which covered valley and river with hundreds of feet of volcanic material and formed Table Mountain by the subsequent wearing away of the mountains on either side. The direction of current of the ancient river and its average fall in one hundred feet are about the same as the neighboring ravine. Accompanying the gravel there often occurs wood, composed of trunks of trees and branches more or less carbonized and often turned to lustrous coal. It is here in this district that the ancient river bed was first discovered and followed under the mountain. It was traced to the mountain in working a portion of uncovered gravel, and afterwards the north and south ends of a large river bend which curved under the mountain were discovered.

THE STANISLAUS TUNNEL.

At Reynolds Ferry, on the Stanislaus River, between Copperopolis, Calaveras County, and Sonora, about ten miles from the latter place, a tunnel called "The Stanislaus," seven feet high and nine feet wide and one thousand two hundred feet long, has been driven through Horseshoe Bend, diverting the stream and practically draining the river bed for two and one half miles. Large returns are expected to result from this enterprise, on working this distance of river bed.

THE TIOGA DISTRICT.

This district is situated on the summit of the Sierra Nevada Mountains, on the border of Tuolumne and Mono Counties, near Bennetville. The mines are in slate formation. The principal claims are the Great Sierra, Sheepherder, and Golden Crown. In 1874 a sheepherder found a notice on one of these claims, which are all on the same lode, bearing date of 1860, and by the side of the location monument were found an old pick and shovel. In 1878 the sheepherder returned again and made a location. Since then many other locations have been made on this lode, which may be traced for many miles. The ore, according to competent miners and experts, can be mined and concentrated for $3 per ton, and it is said to contain $25 per ton in gold and silver, on the average, the value lying principally in 5 or 6 per cent of very base sulphurets. The situation as regards wood and timber is unsurpassed, and the opportunity to obtain water power excellent; but the comparative inaccessibility of the mines, and consequent high rates of freight, and the rigorous climate of the high Sierra, have thus far operated unfavorably for a profitable mining experience. The mines, which are said to be of a permanent character, have been opened somewhat by tunneling.

BUILDING AND USEFUL STONE.

There is said to be an inexhaustible quarry of marble eight miles southeast of Sonora. There is a very fine quarry of granite on the Hyde ranch, eight miles northeast of Sonora. The rock is said to be of better quality and color, and more easily worked than that at Rocklin. Several fine monuments in Sonora were made from this material. Some of this granite has been shipped to Stockton. There is a fine quality of soapstone about five hundred yards from Buchanan, and excellent soapstone is found in Sonora, on Woods Creek. Some eighty tons of the material was shipped to the Pacific Rolling Mills at San Francisco for furnace lining, and gave excellent satisfaction for the purposes to which it was applied.

VENTURA COUNTY.

The name of this county is a contraction of the term San Buenaventura, the appellation given to the Mission founded here in 1782, and after which it is called. This county is bounded on the northwest by San Luis Obispo, on the northeast and east by Kern and Los Angeles, on the southeast by Los Angeles County and the Pacific Ocean, on the southwest by the channel of Santa Barbara, and on the west by Santa Barbara County.

The northern part of Ventura is mountainous, the Sierra de Rafael striking east and west across it. The balance of the county consists of valleys, plains, and hills, some of the latter swelling almost to the proportions of mountains. The valleys are numerous, some of them including a large area, and all being beautiful and of great fertility. The soil on the uplands is also rich, in some instances even to the tops of the mountains. Grass grows abundantly everywhere, making this an excellent stock country.

Ventura contains for its size as many sheep and cattle, perhaps, as any other county in the State. In its production of honey it heads the list, there being some eighteen thousand beehives in the county.

The county is extremely well watered, the Santa Clara River, fed by the Santa Paula, Sespe, and Piru, all considerable streams, flowing west entirely across it. Through the Simi Valley further south runs a large creek of the same name, there being numerous smaller streams elsewhere in the county. Ventura is, however, poorly timbered, the tree growth here being confined to a scrubby species of pine on the mountains and to oak at lower altitudes, with willow and sycamore along some of the watercourses.

BUILDING STONES.

The Sespe brownstone, which, during the past year, has achieved such a prominence among building material in Los Angeles and the lower part of the State, is obtained from the Sespe Cañon, one of the principal cañons in the Sierra Pinal Mountains. This cañon is formed by the waters of the Sespe River, which empties into the Santa Clara three miles from the mouth of the cañon. In the summer this river carries but a few miner's inches of water; but in winter it often becomes a roaring torrent, capable of moving bowlders many tons in weight. The waters of this river are in places covered with a film of oil from the petroleum springs that run into it. The brownstone quarries and oil wells in this cañon are situated in the Little Sespe Mining District.

There is a stratum of friable argillaceous sandstone dipping to the west at an angle of about 30 degrees. This is overlaid by a stratum of sandy shell marl, six or eight inches thick, and apparently decomposed calcareous sandstone and shale rocks. At the entrance to the pass there is evidence of very great disturbance of strata; the formation to the southwest of Mr. Dye's house pitching a little east of north, at an angle of about 70 degrees, while upon the opposite side of the creek the outcrop pitches west of south at a somewhat similar angle; and in close proximity on the same side of the stream, are outcrops pitching east of north at an angle of about 80 degrees. The first working of the Sespe brownstone was by the Gilbert Company, who have worked the immense bowlders found for several miles in the bed of the Sespe River and upon adjacent land, such as may still be found upon the Acres estate at the mouth of the cañon, and upon the adjoining Kentuck claim. This claim is situated at the south end of the Big Sespe Cañon, near the mouth of the Little Sespe, which

here enters the Big Sespe from the east, in the Little Sespe Petroleum Mining District.

The only quarrying as yet on this claim has been upon the bowlders in the creek and on the sides of the cañon—the brownstone formation may here be said to commence. Crossing to the east bank of the Sespe, and ascending the cañon formed by Bowlder Creek, which also enters the Big Sespe at this point, an outcrop of the brown sandstone is reached at the height of about two hundred and fifty feet above the river. The formation here dips to the east of south at an angle of about 60 degrees. The strike of these croppings, if prolonged westerly, would coincide with that of the croppings on the northern bank of the Sespe near the buildings of the Los Angeles Company.

Further on at a height of three hundred and seventy-five feet above the river the brownstone intercalated with shale is again encountered, dipping to the north of east at an angle of 35 degrees. These sandstone strata are from two to ten feet thick, and appear nearly free from pebbles, which are so great a detriment to building stones. Higher up at an altitude of about six hundred and twenty-five feet above the river, the sandstone crops out in ledges from two to fourteen feet in thickness, still dipping to the north of east at an angle of about 35 degrees. The sandstone at this point appears free from pebbles.

LOS ANGELES GRANITE AND BROWNSTONE COMPANY.

This quarry is situated three miles north of the Southern Pacific Railroad. A good wagon road leads from the quarry to the depot. The ditch of the Sespe Land and Water Company flows down the cañon along the side of the river. Quarrying was commenced on this claim in March, 1887, since which time over seventy-five thousand cubic feet of stone have been shipped to Los Angeles and other places, a large portion of which has been cut from bowlders. The first work done here was near the junction of the Big and Little Sespe, and was afterwards continued to the north of the buildings belonging to the company. These buildings are situated about half a mile west of the junction of the two streams on the south bank of the Big Sespe. Near the house the pitch of the rock is east of north at an angle of about 55 degrees. At many places in the vicinity there is evidence of great disturbance of strata; in the bed of the creek there is almost a synclinal axis. On the north bank, level with the buildings, the strata pitch east of south at an angle of 60 degrees, while on the south bank they pitch to the northeast at an angle of some 10 degrees less. The sandstone is for the most part a compact and somewhat coarse-grained rock of a reddish-brown color. It is stated that this stone has been supplied in Los Angeles for $1 25 per cubic foot, at a fair margin of profit. The quarries most recently worked are situated about two hundred yards west of the buildings of the company, also about fifty yards further to the southwest upon the same side of the creek.

At the latter place there is a ledge about thirty-two feet wide consisting of four principal strata separated by thin ledges of shale. These strata are nearly perpendicular and have a slight pitch to the east of north. Towards the contact surfaces of some of these strata, the sandstone passes into a conglomerate of granitic and quartzose pebbles cemented by coarse sand of the same dark color as the sandstone itself.

Above and to the northeast of this outcrop is a thin stratum of light-colored conglomerate, above which the sandstone appears to be more disturbed and broken, and has been eroded for several feet back into the mountain.

The same is true of the intervals between the ledges, twenty, twenty-four, and ten feet wide, respectively, which crop out a few yards further to the south. Between these the sandstone and shale are intercalated at frequent intervals, and cross fractures have rendered that portion of the formation more susceptible to the destructive action of time and the elements, which the main ledges, now standing out in bold relief, have withstood.

As one ascends the Sespe the indications of geological disturbance are very marked. The river bed is strewn with bowlders of sandstone, both the brown building stone and a lighter colored rock from the oil measures. About half way between the last derrick of the Los Angeles Company and the Devil's Gate, which are distant from each other a little over a mile, a lighter colored sandstone protrudes from the northern bank. Underlying it and dipping a little east of south at an angle of about 50 degrees is a succession of strata of fine-grained sandstone and shale, these extending for several hundred feet and varying from less than an inch to several feet in thickness, the most remarkable feature being the thinness of the strata and the rapidity of their succession.

DEVIL'S GATE

Is a fissure through which the Sespe flows. It is a transverse rupture of the sandstone strata which here crop out in a succession of ledges from two to twelve feet in thickness, dipping to the east of south at an angle of about 50 degrees.

Interstratified with the sandstone and occurring irregularly through it, is a conglomerate of jasper and quartose rock. Erratic pebbles are also distributed through the sandstone, being noticeable both in the bowlders and in the strata wherever a cross section is exposed. The creek bed at the Devil's Gate is about one hundred and fifty feet higher than the quarry of the Los Angeles Company. A small creek, locally known as Cold Water Creek, here empties into the Sespe, coming from the southwest. To the north of the Devil's Gate is the Eastern Star Claim. About three hundred yards north of the Devil's Gate a light-colored sandstone is met with which dips to the east of south at an angle of about 55 degrees.

At the lower and southern end of this claim, at an altitude of about fifty feet above Devil's Gate, there is a petroleum spring which runs down into the river. A short distance further north a soft, light-colored sandstone makes its appearance, still dipping east of south, under which bituminous shale crops out. Accompanying this shale is a vein of ferruginous matter. Further north a hard, light-colored sandstone underlies the bituminous shale. At the northern and upper end of the Eastern Star Claim is a second petroleum spring, which also runs down into the river. The bed of the Sespe is here filled with huge bowlders, some of which measure twenty-five by fifteen by twenty feet.

Next to the Eastern Star, further up the cañon, is the Escondido Claim of brownstone and oil, which extends up the stream for two thousand feet. The brownstone formation is here probably over two thousand feet thick and dips to the east at an angle of 20 degrees. It rises in precipitous cliffs on both sides of the cañon to the height of about one thousand feet, while the summit of the hills of which they form a part lies further back at a very much greater altitude.

VENTURA COUNTY.

By Dr. Stephen Bowers, Assistant in the Field.

This article is simply a preliminary to a more extended report on the geology, mineralogy, and other resources of the county which, I trust, will be made in the future. The county includes the islands of San Nicolas and Anacapa. The former is about eighty miles south of Ventura and the latter eighteen miles. The area of the entire county is one thousand eight hundred and sixty-nine square miles, or one million one hundred and ninety-six thousand acres.

The valley of the Santa Clara extends along the seashore from San Buenaventura to Point Magee, a distance of over twenty miles, and extends in an easterly direction across the county, narrowing to two or three miles on the eastern border. A chain of mountains extend from Newhall, in Los Angeles County, westwardly to within about ten miles of the ocean, separating the upper portion of the Santa Clara from the Simi and Los Posos Valleys. The chain is narrow and comes to a sharp ridge or comb at the top, averaging about two thousand feet in altitude.

Thirteen miles north of San Buenaventura is the Ojai Valley, about ten by five miles in extent. It is divided into two valleys, upper and lower. The latter is eight hundred feet above the sea level, and the former about one thousand seven hundred feet. These valleys are surrounded by mountains, opening along the Ventura River to the south. On the eastern portion of the county is the Coneji Plateau, which is several miles in extent and elevated nine hundred feet above the ocean. It is really a succession of hills and valleys. The rock exposures here are principally trappean and metamorphic. The remaining portions of the county are mainly mountainous, giving a diversity of soil and climate.

It is by far the best watered of all the southern counties. The Santa Clara River runs through the county in a westerly direction, reaching the ocean a few miles east of San Buenaventura. The Matilija, San Antonio, and Coyote Creeks unite and form the Ventura River, coming in from the north and supplying the town of San Buenaventura with an abundance of water. The Santa Paula, Sespe, and Piru flow into the Santa Clara from the north and west, the Sespe having its rise in Santa Barbara County. The Lockwood flows into the Piru at the western base of the Almo Mountain. The Cuyama rises near Mount Almo, and runs westwardly to the county line, some fifteen miles distant. The Los Posos Creek waters the Los Posos and Simi Valleys on the eastern side of the county. In addition to these rivers and streams, there are numerous small creeks and springs scattered here and there throughout the county.

THE SAN EMIDIO UPLIFT.

The uplift in the northern portion of the county that was formerly called the San Emidio, is now designated by several local names, as Fraser, Fitzgerald, Alamo, Brown, and Pinos Mountains.

In this section is located what is known as the Piru Mining District. A personal examination of the above named mountains and the San Emidio Range in general induces me to believe that they are older than the formation south of the Sespe. These mountains are composed largely of granite, syenite, talcose slates, and quartz rocks; with fissure veins containing the precious metals. The only fossils I was able to obtain were from the San Emidio Cañon, below the smelting works of the antimony

mine. The range in which they are found is capped with metamorphic sandstone dipping northwardly, which has fallen in vast quantities at the foot of the mountain as talus. The fossils belong to the eocene or the cretaceous. I am inclined to refer much of the uplift north of the Sespe to the cretaceous. From Fitzgerald Mountain, at an altitude of about eight thousand feet, I obtained a good view of the country lying to the east, and believe it not improbable that this uplift and that in which the Calico Mines are located in San Bernardino County are synchronous. Professor Whitney believes a portion of this uplift belongs to the Sierra Nevada Range, but just where it joins the Coast Range he is in doubt.

Mount Pinos is placed by the map-makers in Los Angeles County but I found the greater portion of the mountain to be in Ventura County, the longer axis being nearly east and west. My barometrical measurements give the altitude of this mountain as nine thousand two hundred feet, which is the highest land in Ventura County. There is an interesting trappean uplift on the south side of this mountain, which may be traced some fourteen miles westward to the Cuyama River and more than that distance eastward to the Lievre Ranch House. The main ridge of this uplift is four or five hundred feet high, and in places separated for a mile or more from the mountain. The rocks are amygdaloidal, the cavities filled with zeolites and inspissated bitumen. I obtained beautiful specimens of zeolites composed of quartz, chalcedony, agate, opal, calcite, natrolite, etc. At the point where I made an examination of this uplift, some four miles northwest of Snedden's, it is about one mile wide and contains a stratum of limestone on the south side. Springs holding carbonate of lime in solution issue from each side of the ridge and have formed large masses of calcareous tufa. The water of some of these springs is exceedingly cold in the hottest weather. This trappean uplift seems to have occurred after the formation of the San Emidio Range.

THE PRECIOUS METALS.

The Piru Mining District is several miles in extent, the most important portion lying in Ventura County. Gold was discovered here long before the gold excitement of 1849. Professor Whitney says it was somewhere in this vicinity that gold was first obtained in California in considerable quantity, and that was as early as 1841. M. Duflot de Mofras says that the locality was in the mountains six leagues from San Fernando and fifteen leagues from Los Angeles, where gold was first discovered. Bancroft makes mention of the fact of this locality having been worked more or less during the first half of the present century. It is evident that the yield of gold and silver of this locality has amounted to a large sum in the aggregate.

THE SAN EMIDIO ANTIMONY MINE.

The San Emidio Antimony Mine was located by its present owners in 1872. It is claimed that this ledge was known to the Jesuit fathers at an early day and was worked under their direction. I learn that there is a record to this effect in some of the old missions and that implements have been found here and elsewhere in this portion of the country indicating their use in these mines many years ago.

Professor William R. Blake, who visited this locality in 1853, as geologist and mineralogist of the expedition surveying a route for the Pacific Railroad, refers to this deposit of antimony, and says that in one place he found the remains of some old smelting works. Mr. Blake revisited this

locality some years afterward, being much impressed with the character of its mineral deposits. In his reports he believed the antimony of sufficient importance to pay for transportation to San Pedro on mules, a distance of over one hundred miles, to what was then the nearest seaport. The ore is principally sulphuret of antimony. The vein crops out on the summit of San Emidio Range, and is from thirty to one hundred feet in width. The hanging and foot-walls are composed of granite. The ore is carried on donkeys over a trail two and one half miles to smelting works in San Emidio Cañon, which is two thousand five hundred feet below the vein at the place where it is being mined. Here is a pulverizer and three concentrators, with other machinery, run by steam power.

Messrs. Boushey & Co., the owners of this mine, are preparing to erect a tramway or slide from the mine to the works, which will be about one and one half miles in length. There is an abundance of pine timber growing near by that may be utilized for the purpose, while in the cañon, where the smelting works are located, is a never failing stream of water. The ore averages from 30 to 35 per cent of antimony. It is also stated that it contains from $4 to $16 per ton in gold, and from $10 to $14 in silver. Owing to a combination of circumstances, but principally from the want of capital, these works have been idle for some time past; but at the time of my visit (in July) they were ready to start again. I observed that the machinery was in good order, and that the mineral brought down from the mine was of excellent character.

The mountain west of this ledge is capped with metamorphic sandstone, which Mr. Boushey has tested for lining the furnaces of his smelting works, and pronounces it equal to the best imported firebricks. He showed me some of this stone that had been subject to frequent intense heat in his furnaces, and it was apparently uninjured.

THE BROWN MINE

Is located on the west side of Brown Mountain, one mile south of Lockwood Creek. The country rock, as elsewhere in this district, is principally granite and syenite. The former contains large crystals of rose-colored feldspar. The vein matter of this claim is about three hundred feet wide, with granite walls on either side, the strike being east and west. Gold-bearing quartz is found between these walls, while near the center is a rich streak of ore from fifteen to eighteen inches in width which is said to assay far up into the hundreds. On each side of this streak is pay ore, making a width altogether of four feet, with hanging and foot-walls of talcose slate. Some clay and talc are found mingled with the ore.

This is a true fissure vein, standing nearly vertical, dipping slightly to the south. A tunnel has been run into the mountain on the vein for a distance of one hundred and ten feet at an altitude of five thousand seven hundred feet, and a shaft has been sunk on the vein to a depth of eighty feet. At the bottom of the latter the vein matter widens to six feet. This mine yields free milling ore averaging from $10 to $70 per ton. A slide or tramway could easily be constructed to the Lockwood Creek, one mile distant, a stream which affords abundance of water the entire year for running a large stamp mill or other machinery required for the reduction of the ore. Pine timber is found in sufficient quantity on the sides and top of the mountain to construct a tramway and for all other purposes necessary in working the mine. This mine is owned by Messrs. Menzies and Wilhoit. Several other ledges of good-looking quartz occur on this mountain, two of which run parallel with the vein of the Brown Mine.

THE FRASER MINE

Is located on a mountain of the same name. Work was begun here about twenty years ago, since which it has had a varied history. The early reduction works were arrastras, and it is said to have yielded much wealth. But owing to the fact that it has been in litigation, and from other causes, its later showing is hardly equal to the first. The altitude of the mine is six thousand five hundred feet above the sea level. The vein from which the ore is obtained runs southeast and northwest, and is nearly vertical. Seven tunnels have been excavated, varying in length from forty to five hundred feet. The vertical depth reached from the surface is four hundred and twenty-nine feet. The hanging and foot-walls are composed of porphyry, gneiss, and talcose slate. The ore yields gold, silver, and copper. The company owns a ten-stamp mill, but during the litigation referred to it has fallen into disuse, and needs repairing. Happily the matter is now settled and a responsible company controls the mine, and we learn that work on the mine will be pushed forward at once. The ore yields 4 to 7 per cent sulphurets. The company has constructed six miles of road, but for several years only assessment work has been done on the mine. The deposit of this ore bed is somewhat peculiar. There seems to be a large chimney formed by the junction of several veins of mineral, yielding on an average $15 to $18 per ton.

THE FOLEY MINE

Is located on the south side of Fraser Mountain, seven thousand feet above the sea level. The vein runs east and west and averages four feet in width. The hanging-wall is composed of porphyry, and the foot-wall consists of slate and quartzite. The granite walls on either side of the ledge are about sixty feet apart, and the uplift is similar to the Brown Mine already described. A tunnel has been worked along the vein for about one hundred feet, and a shaft has been sunk vertically about fifteen feet, when it turns south at an angle of 45 degrees for fifteen feet further, and then becomes a tunnel starting west on the ledge. This ore is largely free milling and is apparently good, though I have no actual assay tests. The mine is owned by Messrs. Foley and Campbell.

THE WHITE MULE MINE

Is located on the west side of Fraser Mountain, at an altitude of six thousand five hundred feet. The vein, or rather three veins, averaging two feet each, run east and west with a dip to the north of 23 degrees. An incline tunnel has been run along these veins for over one hundred feet. The first thirty feet incline at an angle of 23 degrees, when it becomes nearly horizontal, terminating in a nearly vertical incline. The lode is in three layers or fissures separated two and one half and seven feet, respectively. The spaces between these veins are filled with talcose slate. At the end of the incline the veins are nearly vertical and seem to be coming together. The incline is near the center of the ledge, and the veins may be traced over seven hundred feet both east and west of the excavation. The proprietors, Messrs. Reed, Hazleton, Haylock, and Lockwood, report that fire tests show that the ore averages about $90 per ton, and are sanguine that they have a rich claim, which I am not inclined to dispute.

Immediately below the White Mule Mine, Messrs. Ramey and Ball have a placer claim, which they are working with the Freeman dry washer. It

is located in a gulch on the west side of Fraser Mountain, about four miles from the summit and two miles from the valley. There is some water in the cañon, but not enough to interfere with the miners. The capacity of the washer is about eighteen tons per day. Two pans of dirt were washed in my presence, the first yielding gold to the value of about 6 cents and the second 50 cents. During the day a small nugget, worth about $1, was found. The yield is mostly coarse gold and about $5 per day is realized.

THE CASTAC MINE

Is situated several miles below Fraser and Brown Mountains, in what is called Snowy District. A five-stamp mill is in use here, crushing about two tons per day, and is run by water power. The course of the vein is north and south, with a dip of 20 degrees to the east, and averages four feet in width. A tunnel three hundred feet long has been run into the mountain, and a vertical shaft has been sunk thirty-five feet. The hanging-wall of this mine is syenite and the foot-wall granite. A cable tramway transports the ore to the works at a small cost. The ore, some of which carries a large percentage of free gold, is free milling.

There are many other claims in the Piru District that have been worked more or less. Usually, however, enough only to hold them, but much apparently good ore is on dumps awaiting the advent of milling facilities, etc. I have only reported upon the mines now being worked. There are several claims, which residents esteem among the best, that are held by heirs and non-residents, which have only assessment work done each year in order to hold the same.

On the east side of the range skirting the Lockwood Valley, rich "float ore" has been picked up from time to time, the apparent value of which has caused much excitement amongst miners. Some of this ore is said to have assayed as high as $30,000 to the ton. As a result no inconsiderable sum has been expended in the aggregate in seeking for the vein or lode from which it originally came. But in my examinations I observed that the formation in this valley is probably largely due to the action of ice. There are several places where hillocks composed of bowlders, gravel, and sand, indicate the stranding of icebergs, which have possibly brought this float ore from northern regions; and I wish to suggest that further expenditures of time and money in search of the original ledge would prove as unprofitable in the future as in the past.

It may be asked why these mines have not been more extensively developed. Some who have not been on the ground are ready to believe from the fact that they have not yielded more gold, that there is little mineral wealth here. In reply I would say that the men who are holding these claims are generally poor, and are unable to purchase and erect mills. A few have been of the "easy-go-lucky" kind, and like Micawber have waited for something to turn up. On the other hand, men of industrious habits who started in to develop these ledges soon found themselves lacking in means to carry the work forward. Then much of the energy expended here has been misdirected. Men ignorant of minerals and mining have erected cabins and have located claims destitute of mineral, instead of working on fissure veins, which are somewhat abundant in the district. Others have had no intention of working their claims further than to show that they contain some mineral wealth, which slight development they hoped would be sufficient to induce men of capital to invest. In this way the district has been kept back from year to year, instead of being the flourishing mining locality which its prospects seem to warrant.

I will conclude my report on these mines with an extract from the report of the Director of the Mint upon the statistics of the production of the precious metals in the United States for the year 1882, in which he speaks of this district as follows:

"The Piru District takes its name from the Piru Creek, which runs through it in a southerly direction, carrying, according to season, from one hundred to one thousand inches of water, and has placer diggings along its banks that have been profitably worked. It is about fifty miles in length by twenty-five in width, and is a strongly marked mineral belt, carrying mineral veins of almost every kind, such as gold, silver, copper, lead, tin, iron, bismuth, and antimony. It is abundantly supplied with timber of all kinds and grass. It seems never to have attracted the attention of that class of men who get up booms in mining camps. Those who frequent it are poor men, who go there to make a raise, working the rich gold quartz they find in arrastras. The district is in Ventura County, and the part around which the principal interest centers and the work is mainly done, is distant fifty-five miles from Bakersfield.

"The principal lode is called the Fraser Mine. During the time it was worked, a period of eight years, until operations ceased October 31, 1879, because from litigation arising from disputed ownership, it is believed to have yielded about $1,000,000 in gold. The difficulty is now said to be on the eve of settlement, and it will be worked by improved methods and on a larger scale than heretofore. The vein varies from two to sixteen feet in width and will average eight feet. The ore contains a small percentage of silver, which seems to increase with depth. At the depth of two hundred and fifty feet it amounts to $6 per ton, while there was only a trace on the surface. The ore contains iron and other sulphurets that assay from $300 to $3,500 per ton. They are all saved, but there is no means of treating them at the mine. The yield in free gold is from $15 to $25 per ton. There are many other claims in the vicinity that are successfully worked, yielding from $500 to $3,500 yearly by the arrastra process. One of these, the Castac, has yielded about $15,000.

"Some of the most valuable lodes cannot be worked by the free milling process, because they contain lead, and, therefore, lie idle for the present. One of these, the Mountain Chief, a large, well defined vein, gives an average of $31 in gold and $40 in silver per ton. The ore is also charged with rich sulphurets. Probably one of the most valuable lodes in the district, if it were in some other place, is a vein of magnetic iron fifty feet in width, containing 52 per cent of this useful metal."

MINERAL OILS

Owing to the vast mineral oil deposits in this section, Ventura is known as the "oil county" of California. The oil belt starts from near the eastern line of the county, and runs in a southwesterly direction to Rincon Creek, which separates Ventura from Santa Barbara County. It is also found near the Conejo, and in other places in the county.

In addition to the report relating to these deposits, prepared by Mr. Goodyear, and published in the Mining Bureau reports of last year, I have to say that work has steadily progressed, and the output of oil for the last fiscal year has increased from sixty-two thousand five hundred barrels to two hundred and twenty-six thousand and fifty barrels.

The following is a statement of the work which has been done in this district during the year ending September eighteenth:

Hopper Cañon.—Considerable work has been done in this cañon, but the returns have been meager. The formation is so broken up that it is not unlikely that the oil exudes at the surface as rapidly as it is elaborated below. There are few portions of the country where the rocks are heaved and shoved at every conceivable angle and present such a scene of utter confusion as they do here. But, in order to thoroughly test this locality, two wells have been drilled during the past year, one four hundred feet deep, and the other about eight hundred feet. In the deeper well a small amount of oil was struck and a large flow of water. In the four hundred-foot well a flow of soda water was obtained, which is said to be of excellent quality, and may be profitably utilized.

Piru Cañon.—Like Hopper Cañon, this seems to be outside of the paying oil belt. Two new wells have been drilled here during the past year. One of them was sunk to the depth of eleven hundred feet, but no oil was obtained, and it was abandoned. Another well was sunk one fourth of a mile east of the former, but it was abandoned for the same reason.

Sespe Cañon.—The efforts of the oil company have been much more successful here. Eight new wells have been drilled during the year, which in the aggregate yield a large quantity of oil.

No. 7 is located about thirty rods southwest of No. 5, described in the last annual report. The depth reached was three hundred feet. When first completed the well produced twenty barrels a day, but now yields ten barrels daily.

No. 8 is located about eighty rods north of No. 4, which was also described in the last annual report. It was drilled to a depth of six hundred and fifty feet and yielded seventy-five barrels a day, which is now reduced to forty-five barrels.

No. 9 is located about six hundred feet from No. 4, and is down to a depth of four hundred feet and is producing about eight barrels a day.

No. 10 is located about five hundred feet south of No. 7 and nearly west of No. 5. It is three hundred and fifty feet deep and pumps seventy-five barrels a day.

No. 11 is southwest of No. 8, and is down to a depth of about four hundred feet. It produced thirty or forty barrels a day when drilled, but quickly ran down to about nine barrels, which amount it is now producing. Wells Nos. 10 and 11 produce oil of greater gravity than any other wells in the district.

No. 12 is five hundred feet north of No. 8, and is about six hundred and fifty feet deep. This well produces seventy-five barrels daily.

No. 13 is located one half mile north of No. 12, in Irelan Creek. It is six hundred feet deep and pumps ten barrels a day.

No. 14 is sixty rods west of No. 13, and was drilled as a test well, going down to a depth of one thousand four hundred feet. In passing through a thin stratum of sand rock about five hundred feet below the surface a small deposit of oil was struck, but the well is practically dry.

No. 15 is forty rods south of No. 13, and is still drilling at a depth of seven hundred feet. Considerable water has been struck and a small quantity of oil.

No. 16 is down about one hundred feet and still drilling.

These wells are located twenty-five miles from the ocean, at an altitude of two thousand eight hundred feet. Mr. John Irwin, the Superintendent of the Sespe District, informs me that the first formation passed through is sand rock, with calcite intrusions. Next comes a grit rock containing heavy oils, the lighter oils being usually found below a limestone forma-

tion, and in a different sandstone, which disintegrates after exposure to the air.

Adams Cañon.—Well No. 16, which was completed in January, at a depth of seven hundred and fifty feet, is the largest flowing well ever struck in California. The oil, when reached, shot up to the height of nearly one hundred feet, and flowed at the rate of eight hundred or nine hundred barrels daily. Before it could be controlled it sent a stream down the cañon for a distance of seven miles. After the lapse of nine months it continues to flow at the rate of five hundred barrels daily.

No. 17 is drilled to a depth of about one thousand four hundred feet, but is a small producer, barely paying for pumping.

No. 18 is located about four hundred feet south of No. 9, and is about nine hundred feet in depth, and still is in process of drilling.

The wells in this cañon are generally quite productive. No. 13, when one year old, had produced seventy-four thousand barrels, and is still producing two hundred and twenty barrels daily.

Saltmarsh Cañon, which is a branch of the last named cañon, promises well.

Well No. 1 was completed in January, of this year, at a depth of two hundred and ninety feet, and is producing seventy-five barrels a day.

No. 2 is four hundred and fifty feet east of No. 1. It was drilled to a depth of three hundred and fifty feet, when it had to be abandoned on account of "crooked hole" and caving.

No. 3 is located about five hundred feet west of No. 1, and is finished to a depth of four hundred feet. It is producing forty barrels per day.

Wheeler Cañon.—Three wells have been drilled in this cañon since the last annual report, but they are producing only about ten barrels a day in the aggregate.

Aliso Cañon is located about two miles west of Wheeler Cañon. A well is drilling near the head of the cañon with fair promises of striking oil in paying quantities.

The No. 16 well in Adams Cañon is probably also the largest gas well on the Pacific Coast. At the present time it is producing sufficient gas to run all the works and machinery in the cañon.

Refinery.—The Hardison & Stewart Oil Company have erected refining works at Santa Paula during the past year which are claimed to be the most complete of the kind in the country. The machinery and the equipment in general include the latest improvements for oil refining.

This company manufactures benzine, illuminating oil, gas and domestic fuel, distillates, wool oil, neutral oil, lubricating oils, and maltha. The crude oil yields from 15 to 20 per cent of illuminating oil and from 20 to 25 per cent of maltha or asphaltum. The illuminating oil is of excellent quality, and claimed to be superior to any that has been made on the Pacific Slope. It burns with a clear and steady flame, and is free from smoke or disagreeable odor.

The asphaltum is used for pipe dipping, for the manufacture of paints and varnishes, and for coating roofs, bridges, etc. It is a beautiful, glossy black, is absolutely impervious to water, and is particularly adapted to coating iron.

The lubricating oil is said to have a lower cold test than any other ever discovered in the United States. It does not harden until it reaches a much lower degree of cold than any other oil known, hence is adapted to locomotives and other machinery subject to cold weather.

NEW COMPANY.

Recently a new company has been organized with headquarters in Los Angeles. It is incorporated under the name of the Ventura Oil Company. The territory in which it is operating is Sec. 21, T. 4 N., R. 20 W., leased by Dr. S. P. Guiberson & Son. The company will thoroughly test the locality. The drill started about August fifteenth, and at this writing is down over four hundred feet, with a strong flow of gas. The well is located five miles from Santa Paula, on the oil-bearing rocks that extend along the south side of Cayetano Mountain, at an altitude of about one thousand seven hundred feet.

BUILDING STONE.

This county is well supplied with choice building stone. Since the advent of the railroad a ledge of brown sandstone has been discovered and worked on the Sespe. The ledge is nearly or quite vertical, the uplift having caused many joints and fractures. It also contains pebbles and bowlders of quartzite and granitic rocks, which detract somewhat from its value. So far the large bowlders of brown sandstone found in the cañon of the Sespe have been most profitably worked. I was informed that a better ledge has been discovered about five miles above Devil's Gate, on this stream, and that it had been examined by an attaché of the State Mining Bureau, who will doubtless report upon it.

Similar stone to that found on the Sespe has been discovered on Mr. S. C. Gridley's farm, in the Ojai Valley. The outcrop is on the north side of a small valley near the mountains, about two and one half miles from Nordhoff. The ledge is nearly vertical, with a slight dip to the north. But a few tons of the rock have been removed, yet sufficient to reveal the character of the stone, which is a compact reddish-brown sandstone, somewhat harder than that found on the Sespe. There seems to be comparatively few joints or fractures in the stone; it has a good cleavage, and is easily broken transversely. Joining the ledge is a stratum, made up largely of petrified oyster shells, which is said to burn into a good quality of water lime, but I could not learn that it had been thoroughly tested.

This ledge of sandstone may be traced eastwardly for a considerable distance, and I observed indications of it on the side of the mountain west of the exposure. It is covered with soil and chaparral. Less than six hundred feet south of this outcrop is an extensive bed of whitish sandstone, in nearly or quite a horizontal position. It seems to contain a small amount of iron, but otherwise is a good quality of building stone. It has not been worked, however, nor can it be considered as valuable as the brownstone above described. The altitude of these ledges is one thousand two hundred and sixty feet. They are easily accessible, there being a gradual descent to the main road.

There is another outcrop of brownstone near the Ventura River, about six miles north of the City of San Buenaventura. This ledge, like the two former described, is vertical, and is more fractured and broken than either. This feature may change, however, as the quarry is further developed. The rock is soft and friable when first taken out, but soon hardens by exposure to the sun.

Another exposure of brownstone occurs in a branch of the Diablo Cañon, about five miles northwest of San Buenaventura. This has the advantage of being horizontal, and consequently less fractured and broken. The elevation is about one thousand feet, but a wagon road can easily be constructed along the side of the mountain, down to the Ventura River.

These various outcrops of sandstone seem to belong to a continuous uplift, extending from the Sespe to the ocean, a distance of about twenty-five miles. The color and texture are similar. I was unable to examine the whole distance in the direction of the strike, but I predict that the future will reveal it to be one vast and continuous deposit of this material.

There is considerable building stone in the Matilija Cañon, principally sandstone. A valuable outcrop of this stone occurs near the Ojai Hot Springs. In the northern portion of the county granite and syenite are found in unlimited quantities. The granite contains large crystals of rose-colored feldspar, which would present a beautiful appearance when dressed and polished. Building stone, more or less valuable, is found in other portions of the county, while the beach for fifteen or twenty miles is covered with bowlders and shingle, which are satisfactorily used for foundation and walls.

GYPSUM.

A large bed of this mineral occurs in the Ojai Valley, crossing the hill below the grade road that ascends to the upper valley. There is an exposure in the cañon on the south side of the road some fifteen or twenty feet wide, dipping slightly to the east. It disappears under the mountain, but crops out nearly a mile distant on the opposite side. It is situated so that it can be easily worked, requiring the construction of a wagon road but about two thousand feet along the side of the cañon. A large deposit of gypsum is reported to have been recently found in the western portion of the county. It is also found in small quantities in other portions of the county.

VOLCANIC ROCKS.

A most interesting volcanic and trappean uplift occurs in the eastern portion of the county. Trap rocks are met with as we approach the Conejo Plateau, rhyolite being the most common. A few miles east a dark vesicular basalt occurs, similar to that found near Yuma, in Arizona. The mountains here have been raised up to a height of nearly, or quite, four thousand feet, presenting a rugged and picturesque outline against the sky. This uplift may be traced eastward near Los Angeles, along the north side of the San Jacinto Range in San Diego County, near Yuma, and into Mexico. Westward it includes Anacapa, Santa Cruz, Santa Rosa, and San Miguel Islands, which are in a direct line with other portions of the uplift.

BITUMINOUS ROCK.

A ledge of bituminous rock was discovered a few months since in Diablo Cañon, about five miles from Ventura, and is worked by Messrs. Cyrus Bellah & Son. The ledge is about three and a half feet thick, dipping about 30 degrees west. It is on the side of the cañon, and has been prospected a distance of forty feet and forty feet deep. The deposit gradually increases in thickness, and gives promise of being practically inexhaustible. It has been tested by the Southern Pacific Company and others, who pronounce it of most excellent quality. The town authorities of San Buenaventura have ordered sidewalks to be constructed of this material on one of its principal streets, which will test its durability and value for paving purposes. Small deposits of this mineral are found in the upper Ojai valley and other places in the county.

FOSSILS.

Ventura County abounds in the fossil remains of many extinct and recent forms of animal life. Pliocene fossils are found in the foothills skirting the seashore from the extreme western portions of the county to San Buenaventura, and on the north side of the Santa Clara Valley to the Sespe. They consist principally of invertebrates, *Surcula carpenteriana* and other recent forms being prominent. A pliocene uplift occurs on the south side of the Santa Paula Mountains, in which fossils occur in great abundance. The most noted found in this locality are *Echinarachnius excentricus* and *Pecten caurinus*. A low range of hills near the center of the Los Posos Valley, ten or twelve miles from the ocean, contains many varieties of pliocene fossils in a good state of preservation, some still retaining their markings almost perfectly. Among these may be mentioned *Ostrea palmula* and *Janira bella*. *Equus occidentalis* has been found in the pliocene hills just north of San Buenaventura and also near Santa Paula.

The bones of whales and other cetaceans are met with in various portions of the county, but especially along the sides and along the crest of the Santa Paula Mountains. On the summit of this range at an altitude of two thousand feet the remains of a large seal, probably *Eumetopias stellieri*, were obtained by the writer last winter. The skull, several teeth, a portion of the vertebra, and other bones were well preserved. The teeth of sharks and the remains of small fishes are found on this mountain. Also *Turritella huffmani*, a species of a pinna and other forms. Most of these are probably miocene. Fossils of this age are found in the Ojai Valley, at Squaw Flat, near the Sespe, along the Cuyama River, and in other places. Near the headwaters of the Sespe I obtained good specimens of *Astrodapsis whitneyi*. The extreme northern portion of the county I am inclined to refer to the cretaceous.

MINERAL SPRINGS.

The county abounds in hot and cold mineral springs. The most noted of these are located in the Mitilija Cañon, fifteen or eighteen miles from San Buenaventura. They have been in use several years by persons suffering from rheumatism, indigestion, cutaneous, and other diseases. They are found somewhat abundantly for two or three miles along the cañon, varying in temperature from cold to hot. Several medicinal springs are found on the Piru and at other portions of the county, but have not been brought to the notice of the public.

TIMBER.

Timber is somewhat abundant in Ventura County. Live and white oaks are found in the Ojai Valleys, on the Conejo Plateau, the Simi, Santa Ana, in nearly all of the cañons, and on the north sides of mountains. There is a sufficiency of this timber to supply the demands for fuel for many years to come. The cañons also contain sycamore, cottonwood, balm of gilead, soft maple, chincapin, oak, and several species of smaller growth of trees. The Sierra Pinal and San Emidio Ranges, which embrace a large portion of the northern part of the county, are covered with pine and fir. Some of these measure from six to eight feet in diameter and attain an altitude of two hundred feet.

ANTIQUITIES.

When Cabrillo sailed along this coast in 1542, his ships found anchorage in an inlet near Point Magu, close to the eastern line of what is now Ventura County. The next day he sailed up and dropped anchor before a large Indian town, which the natives called Xucu, but which he named Pueblo de las Canoas, on account of the great number of canoes owned by the inhabitants. This site is now occupied by San Buenaventura. He refers to the valley east of Canoe Town (Santa Clara Valley) as yielding maize, which the Indians triturated in mortars, and used for food. He refers to the great number of Indians who swarmed along the shore and lived in towns and villages in the interior. When the Jesuits came to this portion of the country, more than a century since, they selected Xucu as a site upon which to found a mission. They, as well as intermediate navigators, confirm Cabrillo's statement of the multitudes of Indians inhabiting this section of the country.

The great number of aborigines formerly living in what is now known as Ventura County is confirmed by the numerous sites of villages and rancherias. These may be found along the seashore and along the banks of rivers and streams, and indeed in nearly every spot where fresh water could be obtained. The rancherias and burial places yield mortars, pestles, ollas, bowls, pipes, arrow and spear points, shell ornaments, etc. The genial climate of this section, the abundance of good water, the fertile valleys, the fish and mollusks found in the ocean, with the abundance of wild game, contributed to the prosperity of the natives.

YOLO COUNTY.

The name of this county is said to be a corruption of the Indian "Yo-doy," meaning swamp or tule lands, of which there are some forty thousand acres in the eastern part of the county bordering on the Sacramento River. Yolo is bounded on the north by Colusa, on the east by Sutter and Sacramento, on the south by Solano, and on the west by Napa and Lake Counties.

The eastern half of the county is perfectly level; as it extends west this plain breaks into rolling prairies, which further on culminate in the summits of the Coast Range, which for some distance constitutes the dividing line between this county and Lake. The principal stream in Yolo is Cache Creek running centrally across the county. The Sacramento River forms the county's boundary line on the east and Putah Creek on the south.

The timber in the county consists of some white oak sparsely scattered over the prairies and plains and a little cottonwood along the watercourses, with a small growth of scrubby pine on the mountains; very little of this timber is suitable for making lumber.

So far as known Yolo does not contain any mineral deposits of value, unless it be a variety of building stones and clays. The county, however, has an inexhaustible mine of wealth in its agricultural resources.

YUBA COUNTY.

This county derives its name from the Yuba River, the principal stream flowing through it. The term "Yuba" is said to be an American corruption of the Spanish word *uva*, a grape; this river having been so called by reason of the many wild grapevines found growing along it. Yuba County is bounded on the northwest by Butte, on the east by Sierra, on the southeast by Nevada, on the south by Placer and Sutter, and on the west by Sutter County.

This is for the most part a level county. Only on the east, where the country breaks into the foothills of the Sierra, does it rise much above the sea level, nor does the highest portion of the county reach an altitude of more than two thousand feet. The rivers and larger creeks in this county consist of the main Yuba and its middle fork, the former flowing west centrally across the county and constituting, in part, the dividing line between this and Nevada County; Feather River separating Yuba from Sutter County on the west; Bear River, dividing line between Yuba, Placer, and Sutter on the south; Honcut Creek, its northwestern boundary, and Dry Creek, running across the county from northeast to southwest.

The upper half of Yuba County is covered with the forests common to the lower slopes of the Sierra, the balance of it being timbered with only a sparse growth of oak and a little cottonwood and willow along the rivers. The soil throughout the lower portions of the county is a deep alluvium, capable of producing heavy crops of the cereals; that on the upland being admirably adapted for fruit and vine growing. A good many cattle and sheep are also kept here, being subsisted partly on the cultivated, but mostly on the native grasses. As mining has declined, agricultural pursuits have been on the increase in this county.

The principal towns of Yuba are Marysville, the county seat, Wheatland, Brownsville, Smartsville, Camptonville, and Timbuctoo.

TABULAR STATEMENT OF MILLS.

ARRANGED BY COUNTIES.

Name and Locality of Mills.	Water or Steam Power	No. of Stamps	Weight of each Stamp, pounds	Drop of Stamps in Inches	Drop of Stamps per Minute	Number of Tons Crushed per Stamp in 24 Hours	Number and Kind of Screens.
Amador County.							
Plymouth Consolidated	Water.	80	750	5-6	90	Av. 2	....8 round punched.
Plymouth Consolidated	Water.	80	1,000	5-6	90		
Loyal Lead	Water.	10	700	6-7½	85	1½	..........6 angle slot.
Gover	Water.	20	850	6-6½	85-90	2½	.....6, 7, 8, angle slot.
Bunker Hill	W.or S.	40	850	6½	90-92	2½	..........8 angle slot.
Keystone	W.or S.	40	750	6	92-93	2½	.... 8 straight slot.
South Spring Hill	Water.	30	750	6-7	90-93	2½	....7 and 8 angle slot.
Lincoln	Water.	40	850	7	85	4	..........6 angle slot.
Mahoney	Water.	40	850	7	85	4	..........6 angle slot.
Sutter Creek	Water.	10	850	6	90	1½-2	..........8 angle slot.
Wildman	Water.	10	750	5-6	90	2¼	..........7 angle slot.
Oneida	Water.	10	750	5	85	4	..........6 angle slot.
Live Oak	Water.	2	850	5½-6	93	2½-3	..........6 angle slot.
Kennedy	Water.	40	850	6½-7	88	2⅛-2¼	.... 30 brass wire.
Zeile	W.or S.	40	750	7½	88	3½	.... 4 straight slot.
Moore	Water.	10	850	7	90	3	..........6 angle slot.
Amador Gold	Water.	60	750	6	90	2½	................8 slot.
Amador Queen	Water.	20	950	7½	85	3	................6 slot.
Nevills	Water.	10	750	8	90	2½	................6 slot.
Calaveras County.							
Utica	Water.	60	900	5	100	2½	.0 tin round punched.
Stickles	Water.	20	950	6-8	86	2½	.. 50-mesh brass wire.
Suffolk	Water.	5	600	4-7	80	2	...9 and 10 angle slot.
McCreight	Water	10	650	4-6½	80-90	1½	0 and 1 tin r. punched.
Sheep Ranch	Steam.	30	800	6-8	85	2⅛-2¼	..........9 angle slot.
Esmeralda	Steam.	10	650	4½-7	85-90	1½	..........8 angle slot.
Ilex	S. & W.	40	850	7	95	2	.. 30-mesh brass wire.
Russell Red. & Mg. Co.	S. & W.	5	850	5-6	85	1½	...... 10 straight slot.
Blazing Star & W. Lily	Steam.	3	900	......	....	1½	..........8 angle slot.

		No. of Pulv.	Kind of Pulverizers.	No. Rev. per Min.	Capacity in 24 hrs.	
Russell Red. & Mg. Co.	S. & W.	1	Dodge	25	7½	...... 10 straight slot.
Maltman Red. Works	Steam.	1	Tustin	22	2½	...40-mesh steel wire.
Angels Mine	Water.	3	Low	36	50	.. Expr. various sizes.
Quaker Mine Mill	Water.	1	6-ft. Hun.	50-55	15-20	6,7,8 ang.slot-ex.40-m.
Buena Vista	Steam.	1	Kendall	....	....	....

TABULAR STATEMENT OF MILLS.

NAME AND LOCALITY OF MILLS.	Water or Steam Power	No. of Stamps	Weight of each Stamp, pounds	Drop of Stamp, in Inches	Drop of Stamps per Minute	Number of Tons Crushed per Stamp in 24 hours	Number and Kind of Screens.
El Dorado County.							
Josephine	Water	20	850 / 750	$6\frac{1}{2}$	92	$2\frac{1}{2}$	Angle slot, Nos. 5, 6, 7.
Alpine	Water	10	1,000	4	100	$3\frac{1}{2}$	Straight $\frac{1}{2}$-in. slot, No. 7, steel wire and 30-mesh.
Taylor	Water	10	750	4-5	94	1	Straight $\frac{1}{2}$-in. slot, No. 8.
Vandalia	Steam	5	850	4	90	$2\frac{1}{4}$	Angle slot, No. 8.
Big Cañon	Water	20	850	6	95-104	$2\frac{1}{5}$	Angle slot, No. 6.
Gopher and Bowlder	Water	20	750	4	100	$3\frac{1}{2}$-4	Round punched, No. 0.
Melton	Water	15	800	5	95	$1\frac{1}{2}$	No. 7 punched and No. 50 brass wire.
Oregon	Water	10	750	8	85	$1\frac{1}{3}$	No. 40 wire.
Pacific	Water	20	800	8	82	$1\frac{1}{2}$	Round punched, No. 6.
Superior	Steam	10	750	5	90	$2\frac{2}{10}$	Steel wire Nos. 40 & 50.
Church	Water	10	850	6	85-90	$1\frac{65}{100}$	Tinned iron No. 1, round punched, corre-sp'ndi'g to No. 40 wire.
Chili Ravine	Water	10	550	5	85	6-7	$\frac{1}{2}$-inch mesh.
Linden Gravel	Water	10	550	5-7	95	9	$\frac{1}{4}$-inch mesh.
Rogers Gravel	Water	10	500	6	96	13	$\frac{1}{16}$-inch square mesh.
Zentgraft	Water	10	750	6-7	70	$1\frac{4}{10}$	No. 40 brass wire.

NAME OF MILL AND LOCALITY.	Steam or Water.	Character of Mill.	Diameter of Mill.	No. Rev. per Min.	No. Tons Crushed 24 hours.	Number and Kind of Screens.
Shaw	Steam	Hunt'n Mill	5	50	10-12	Nos. 6 and 7, angle slot.
Mathines Creek	Water	Hunt'n Mill	5	50	9-10	No. 9, angle slot.

TABULAR STATEMENT OF MILLS—Continued.

Name and Locality of Mills.	Water or Steam Power	No. of Stamps	Weight of each Stamp, pounds	Drop of Stamp, in Inches	Drop of Stamps per Minute	Number of Tons Crushed per Stamp in 24 hours	Number and Kind of Screens.
Colusa County.							
Manzanita (gold)	Steam	10	950	6½–7	100	3	8 slot punched.
Fresno County.							
Abbey	Steam	10	800	6	86	2½	9 slot punched.
Hanover	Steam	5	850	6	80	1¼	8 slot punched.
Providence*	Steam						8 round punched.
Confidence	Water	5	600	6	85	1	60 wire.
Last Chance	Steam	10	900	5½	80	1⅛	50 wire.
Josephine	Steam	20	900	5	80	2½	8 and 9 slot punched.
Sampson†	Steam						9 slot punched.
Los Angeles County.							
O'Rielly	Steam	5	1,000	16	90–100	Av. 2	8 slot.
Lassen County.							
Evening Star	Water	10	650	6	90	1½	11 slot.
Golden Eagle	Water	5	600	6	70	1½	11 slot.
Mariposa County.							
Hite	Water	40	750–800	5–7	80	1⅜	40 wire cloth.
Cranberry‡	Water						
Hathway-Bondurant	Steam	10	750	4–6½	95	1¾	10 slot.
Red Cloud	Steam	22	800	6–8	90	1½	40-mesh brass wire.
Monterey County.							
Last Chance Mill	Steam	3				4	40 mesh.
Mono County.							
Standard Con. M'g Co.	Steam	15	850	6½–8½	92	3	30-mesh steel wire.
Monte Cristo M'g Co.‖	Steam						9 slot punched.
Nevada County.							
Champion §	Water						
Rodgers	Water	10					
Larrimer	Water	10					
Bulldozer	Water						
Spanish ¶	Water						5 slot.
Delhi	Water	18	1,000 / 1,100	6	94	2½	10 slot.
Idaho	Water	35	850	9½	72		6 slot.
Gaston Ridge	Steam	10	750	7¾	90	2½–3	6 slot.
Yuba	Water	15	900	7	86	2	40 mesh.
Rocky Glen	Water	10	800	6½	90	$2\frac{8}{10}$	1 round punched.
Blue Bell	Water	10	850	5½–6	88–92	$1\frac{6}{10}$–$1\frac{8}{10}$	30 mesh.
Washington	Water	20	850	5½–6	88–92	$2\frac{2}{10}$	30 mesh.
Brunswick	Steam	20	950				
North Banner	Water	5	1,000	6–7	80	2	4 round punched.
Champion	Water	10	750	6	85	$1\frac{7}{10}$	6 round punched.
Nevada Company	Water	10	850	6	85	2	6 round punched.
Omaha Consolidated	Water	10	900	7	80	$1\frac{6}{10}$	6 slot.
Crown Point	Water	10	750	8	75	1½	30 mesh.
Orleans	Steam	8	900	10–12	60	2⅓	$\frac{3}{100}$-inch slot.
Mayflower	Water	4	950	7–8	80–85	2½	6 round punched.
Excelsior Mine	Steam	10	900	7	85	3	10 slot.
North Star							
Empire							
Rocky Bar							

* Dodge pulverizer, capacity 10 tons.
† Kendall mill, capacity 8 tons.
‡ Two arrastras, capacity 1¼ tons.
‖ Has two Huntington roller mills, driven by a 10x12 horizontal engine, at the rate of seventy revolutions per minute. There are four rollers to the mill, weighing one hundred and fifty pounds each. Each mill crushes one ton of ore per hour, or at the rate of twenty-four tons in twenty-four hours.
§ One Huntington mill.
¶ Four Huntington mills, 58 revolutions per minute, capacity 35 tons.

TABULAR STATEMENT OF MILLS—Continued.

NAME AND LOCALITY OF MILLS.	Water or Steam Power	No. of Stamps	Weight of each Stamp, pounds	Drop of Stamps, in Inches	Drop of Stamps per Minute	Number of Tons Crushed per Stamp in 24 Hours	Number and Kind of Screens.
Napa County.							
Palisade (silver)	Steam.	10	750	8	90	$1\frac{7}{10}$	34 mesh.
Plumas County.							
Crescent	Water.	16	900	7	74	$1\frac{1}{2}$	10 slot.
Plumas Consolidated	Water.	24	850	6	80	$1\frac{1}{2}$	10 slot.
Kettle Mill	Water.	20	850	5	85	$2\frac{1}{2}$	7 slot.
Green Mountain	Water.	60	750	7	75	$1\frac{1}{2}$	10 slot.
Plumas Eureka	Water.	60	850	$8\frac{1}{2}$	80	$2\frac{63}{100}$	8 diagonal slot.
Placer County.							
New Mill		5					
Shipley		10					
Jamison Arrastra	Water.						
Kidd & Johnson *	Water.	5	650				
Dorer	Water.	10					
Bells †	Water.						
St. Patrick	Water.	15	750	$4\frac{1}{2}$–5	80	$1\frac{1}{2}$	40 mesh and 6 round punched.
Dardanelles	Water.	5	930	$7\frac{1}{2}$	101-104	900 cubic ft.	$\frac{3}{16}$-inch round.
Breece & Wheeler	Steam.	10	850	10	85	9	$\frac{1}{8}$-inch mesh iron wire.
Live Oak	Water.	5	1,100	9	100	12	$\frac{3}{16}$-inch round holes.
Morning Star	Steam.	10	850	7–8	65–70	$4\frac{1}{2}$	$\frac{1}{4}$-inch round holes.
Buttes	Water.	5					
Santa Cruz County.							
Stribling Mill	Steam.	5		4		5	12 slot.
Shasta County.							
Celestine	Water.	5	850	$5\frac{1}{2}$	85	$2\frac{1}{2}$	40 mesh.
Lost Confidence	Steam.	20	950	7	90	2	40 mesh.
Central ‡	Steam.					10–13 ea.	8 to 30 mesh.
Calumet G. Mg. Co.	Water.	24	600	6	85	$1\frac{1}{2}$–2	8 slot.
Reilly & Bliss	Water.	10	850	6	90	$1\frac{1}{2}$–2	40 mesh.
America	Water.	5	750	$5\frac{1}{2}$	85	2	9 slot.
Gem Consolidated	Steam.	10	870	6	90	2	30 mesh.
Majara M. & M. Co.	Steam.	18	10-850 8-600	5-$7\frac{1}{2}$	75–85	$1\frac{1}{2}$	40, 50, and 60 mesh.
Uncle Sam	Steam.	10	850	6	85	$1\frac{1}{2}$–2	4 mesh.
San Diego County.							
Stonewall Mine	Steam.	10	750	5	100	2	8 slot.
Ready Relief Mine	Steam.	10	950	5	100	$1\frac{1}{2}$	10 round punched.
Sierra County.							
Young America	Water.	40	750	7	85	2	7 slot.
Sierra Buttes	Water.	80	850	8	86	$2\frac{4}{10}$	7 slot.
Gold Bluff	Water.	12	650	6	60	1	6 slot.
Rainbow Hill	Water.	10	850	7	85	$2\frac{1}{4}$	10 round punched.
San Bernardino County.							
Waterloo—New	Steam	60	850	$6\frac{1}{2}$	100	3	30 mesh.
Waterloo—Old	Steam.	15					
Barbero	Steam.	10	900	7	112	$2\frac{1}{2}$–3	20, 30, and 40 mesh.
Hawley	Steam.	10	700	$6\frac{1}{2}$–8	90-96	$2\frac{1}{2}$	20, 30, and 40 mesh.

* To start soon.
† One Kendall rocker said to crush 7 to 10 tons.
‡ Two Huntington mills.

TABULAR STATEMENT OF MILLS—Continued.

NAME AND LOCALITY OF MILLS.	Water or Steam Power	No. of Stamps	Weight of each Stamp, pounds.	Drop of Stamp, in inches	Drop of Stamps per minute	Number of Tons crushed in 24 hours	Number and Kind of Screens.
Siskiyou County.							
Caribou, S. Fk. Salmon	Water	2	400	4-6	100	¾	6 slot.
Uncle Sam, S. F. Sal.	Water	8	780	7-9	95	2	8 flat punched.
Mt. Laurel, S. F. Sal.	Water	16	650	5-8	80	1¼	11 flat punched.
Evening Star, S. F. Sal.	Water	4	700	6-9	90	1½	8 slot.
Black Bear, S. F. Sal.*	W. & S.	32	650	6-9	80	1¼	7 punched.
Methodist Ck., S. F. Sal.	Water	1	250	4-6	90	¾	11 slot.
The Gilta	Water	4	650	6-8	80	1½	8 slot.
Scott Bar M. & M. Co.	Water	10	750	6-9	80	2	9 slot.
Last Chance	W. & S.	5	700	6-9	90	2	9 slot.
Hooper's L'r Custom	Steam	5	500	5-8	90	¾	8 slot.
Johnson's Oro Fino	Water	10	700	6-8	85	1½	8 slot.
Schroder & Warner	Steam	5	800	5-8	82	1½	11 slot.
Comstock No. 2	Steam	5	400	4-6	100	1¼	9 slot.
Luna	Water	4	550	2½-3	60	¾	7 slot.
Daggett & Smith	Water	5	550	6-7	80	1½	8 slot.
Warren & Green	Water	5	650	6-8	80	1½	8 slot.
Trinity County.							
North Star	Water	5	450	6	80	1¼	40 mesh.
Golden Chest	Water	5	750	8	85	1½	40 mesh.
Bully Choop	Steam	10	800	6	90	2	40 mesh.
Brown Bear	Steam	15	750	6	85	1¼	8 and 10 slot.
Bartred	Steam	10	850	7	86	1½	50 mesh.
Tuolumne County.							
Patterson	Water	20	800	6	85-90	2	No. 50 brass wire.
Madrid	Water	5	650	5	85	1½	No. 50 brass wire.
Experimental Gulch	Water	10	650	4½	90	2½	No. 5 & 6 angle slot.
App	Water	5	625	4½-6	75	1-2	Nos. 40 & 50 brass wire.
Heslep	Water	25	850	5	90	1¼	No. 50 brass wire.
Gem	Water	10	650	4-7	70-100	1	No. 50 brass wire.
Seeber	Water	15	750	6	90	2⅔	No. 40 brass wire.
Con. Eureka	Water	20	750				
New Albany	Water	10					
Black Oak	Steam	10	850	5½	90	¾	No. 50 brass wire.
Buchanan	Steam	20	850	7	90	1½	No. 40 brass wire.
Kanaka	Water	5	750	6	90	1¼	Slot cor. to No. 40 m'sh.

NAME OF MILL AND LOCALITY.	Steam or Water.	Character of Mill.	Diameter of Mill.	No. Rev. per Min.	No. Tons Crushed 24 Hr's.	Number of Screen.
Tuolumne County.						
Golden Treasure	Steam	Hunt'n	5 feet	65	15-25	Angle slot No. 8.
San Guisseppa	Water	Arast'a	10 feet		1	
Belcher Consolidated	Steam	Kend'll oscill't'g			8-12	

*Of the thirty-two stamps, only twelve are running.

The larger portion of the above enumerated mills are run only during the water season. Some are custom mills and run whenever supplied with ore.

THE MILLING OF GOLD ORES IN CALIFORNIA.

By JOHN HAYS HAMMOND, E.M.

MINERALOGICAL CHARACTER OF THE AURIFEROUS ORES.

Mineralogically the ores consist generally of a quartz gangue, carrying free gold and iron pyrites. With the iron pyrites are sometimes associated arsenical and copper pyrites, and more frequently galena and zinc blende. In some of the gold ores are found auriferous tellurides, and also, occasionally, some other of the rarer minerals. These latter constituents are usually of little economic importance; and their presence may practically be disregarded. Quartz is the characteristic matrix of the veins, though other matrices occur. Sometimes the wall-rock fills the vein, and constitutes the gangue of the ore. Calcspar often accompanies the quartz veinstone, though it very rarely forms exclusively the matrix of the auriferous ore.

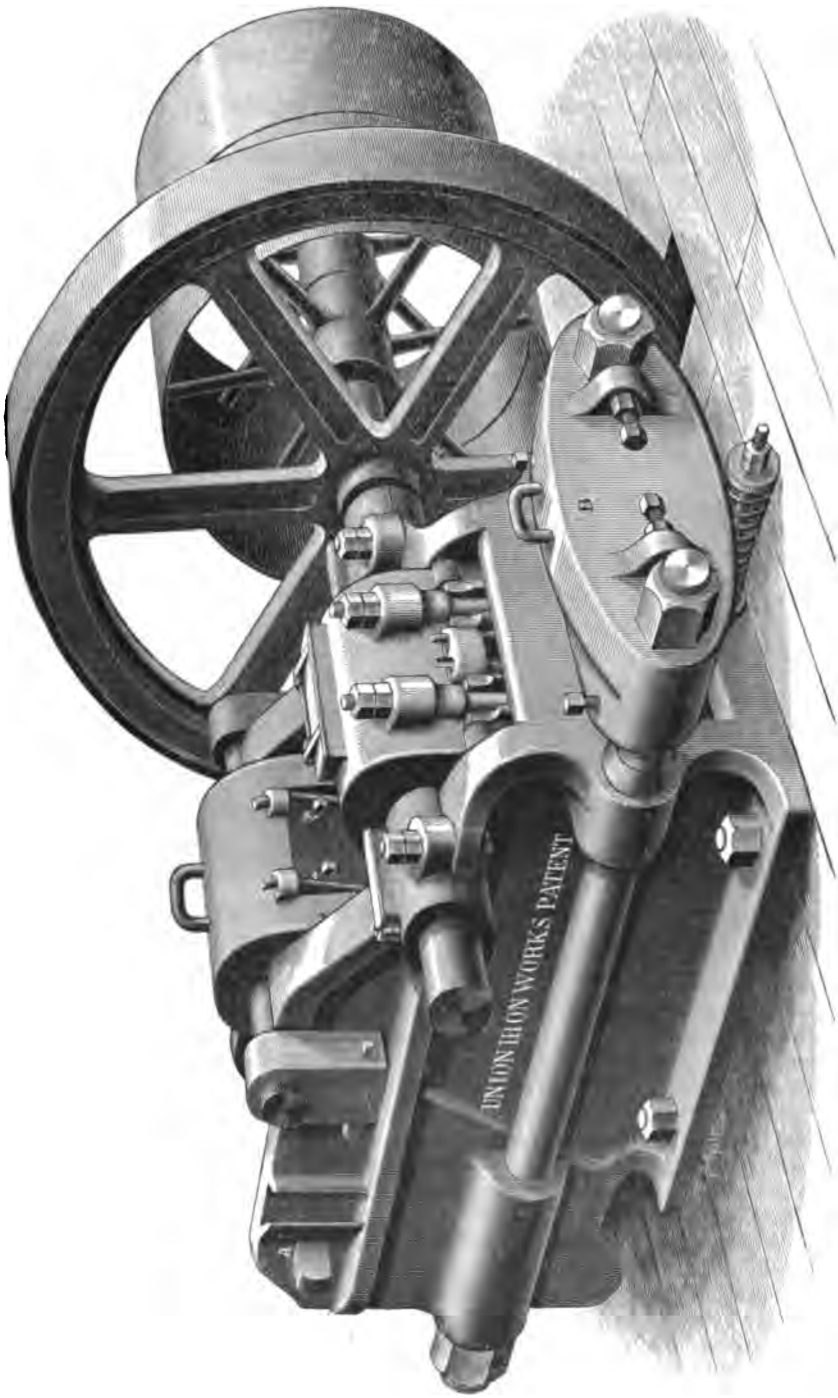
The value of gold ores worked in California generally varies from $3 50 to $8 a ton in the low grade ores, up to $15 to $30 a ton in the high grade ores. I should place $10 to $12 a ton as a rough estimate of the average grade of ore at present treated. The percentage of sulphurets (iron pyrites principally) will vary from 1 to 5 per cent of the ore milled. Two per cent would represent about the average pyritous contents of the ores. The percentage of sulphurets contained in the ore and the value of the concentrated sulphurets are but rarely of so little economic importance as to be ignored in the milling of the gold ores. The great majority of gold mills have their plants adapted to the saving of the sulphurets; the value of which, while usually subordinate to that of the free gold present in the ore, nevertheless is a significant factor in the output of the mill. I should estimate the average value of the sulphurets saved in the State at from $80 to $90 per ton of concentrates. In the low grade ores the gold occurs disseminated throughout the ore in particles rarely visible to the naked eye. In ores of high grade it often occurs massive and sometimes in lamellæ along the planes of division in the quartz ("ribbon rock"). The gold often assumes the form of wire (filiform), and is also occasionally arborescent.

Ores showing considerable free gold ("specimen ore") is often sold to jewelers, who pay from $20 to $27 per ounce of gold contained in the quartz.

The pyrites is generally massive in character, though sometimes it occurs crystallized. Crystallized iron pyrites rarely carries much gold. The sulphurets contained in the country rock inclosing the vein are likewise of but little value.

MILL SITES.

The choice of the mill site is of paramount importance, as upon its judicious selection will depend, in a great degree, the cost of the milling of the ore. Considerations of its accessibility; of the attainable fall, which affects the automatism of the process; of the accessibility of water and wood (where used) should generally determine the adaptability of the mill site. There are, fortunately, but few gold-bearing districts in California where all these desiderata are not attainable.



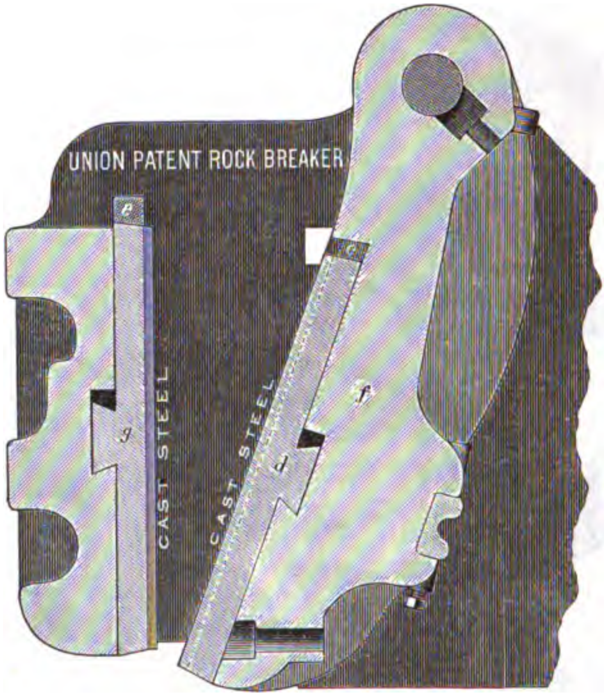
ROCK BREAKER.

OUTLINE OF THE PROCESS.

The ore is discharged as it comes from the mine, upon a grizzly, which separates it into two classes:

First—Ore which passes directly through the grizzly into the main ore bin.

Second—The coarse ore which passes into the coarse ore bin.



JAWS OF ROCK BREAKER.

The ore from Class 2 is passed through the rock breaker, by which it is reduced to the proper size for stamping, thence it passes through the battery, where part of the free gold is extracted by amalgamation. The pulp, from which part of the free gold has been eliminated, passes from the mortars on to the copper plates, and thence to the concentrators. The concentrators effect the concentration of the auriferous sulphurets, the residual pulp passing off into the sluices below the mill, where a portion of the sulphurets and other valuable contents, which have escaped from the concentrators and preceding appliances, is saved by various contrivances. From the sluices the pulp passes away as tailings, or, comparatively speaking, worthless gangue.

Where the topographical conditions admit, it is advantageous to have commodious ore bins.

The consideration of the mill site oftentimes imposes the economy of fall in the disposition of the several floors of the mill. When rock breakers are used at the mill, the least practicable fall that insures automatism in the process (*i.e.*, the use of gravity in moving the ore through the various operations) is thirty-three feet from the rock breaker floor to the concen-

trator floor. By curtailing the length usually given to sluice plates, and having but one concentrator per battery (instead of two, as is customary), the requisite fall may be further reduced to about twenty-nine and one half feet.*

ROCK BREAKERS.

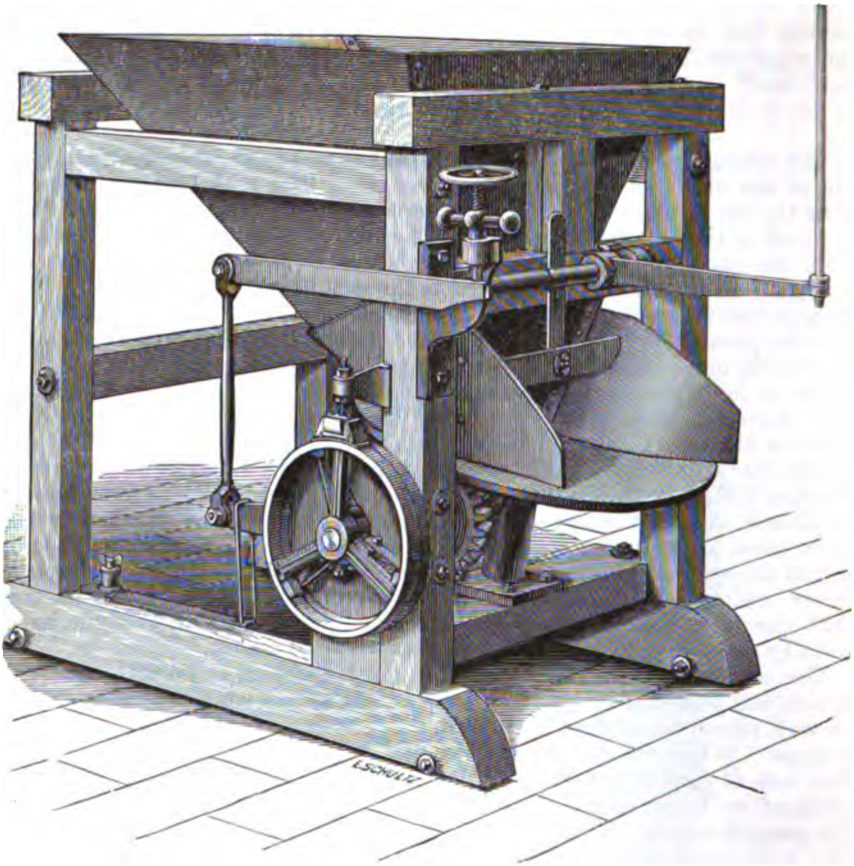
The arrangement of the rock breakers as shown in the cross section drawing of the mill is a very advantageous one. The rock breaker is placed directly below and in front of the coarse ore bin. The chute leads from the gate of the bin into the jaws of the rock breaker. The gate opening from the coarse ore bin into this chute is worked by rack and pinion. By this gate the supply of ore delivered to the rock breaker is controlled. This arrangement insures an almost continuous supply of ore to the rock breaker, thereby greatly increasing the capacity of that machine. In most mills the coarse ore is discharged over the grizzly on to the rock breaker floor, where it is picked up by the man who feeds the rock breaker. This not only occasions unnecessary labor but decreases the capacity of the rock breaker through failure to keep it constantly supplied with ore. At the North Star Mill, where the above arrangement has been introduced, one rock breaker (fifteen inches by nine inches) crushes from thirty to forty tons of hard rock in from five to seven hours, effecting a saving of wages of two or three men, as compared with the labor required in mills arranged according to the system generally adopted. Further evidence of the comparatively unintermittent working of the rock breaker is shown by the fact that the rock breaker requires twelve-horse power instead of eight, as is usually computed for machines of the above dimensions.

The crushed ore goes into the main ore bin, where it joins the fine ore, which has passed through the grizzlies. These two classes of ores should be well mixed to secure uniformity in the character of the charges fed to the stamps. Where the fall permits it will be found advantageous to have two sets of rock breakers; the first crushing coarse and delivering the crushed ore to the second set of rock breakers, to be crushed finer than is the present custom. This would greatly increase the capacity of the stamp. The rock breakers are adjusted to crush the ore to pieces smaller than two to three inches. The rock breaker shoes and dies last six to eight months. When of steel they wear about twice as long.

SELF-FEEDERS.

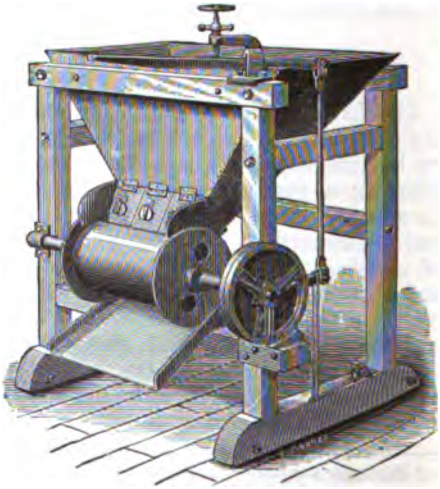
The introduction of self-feeders has greatly increased the effectiveness of the stamp mill, as compared with hand feeding. The use of these feeders has increased the capacity of the battery from 15 to 20 per cent, besides effecting a very considerable reduction in the wearing of screens, dies, shoes, etc. The maximum capacity, other things being equal, of the battery is attained by "low feeding." By low feeding is denoted the feeding of small quantities of ore upon the die. The ore should be fed steadily and in small quantities. When fed in the mortar with more or less irregularity and in large charges, the ore is piled up to a height that reduces the fall of the stamp and also forms a cushion of ore on the dies that impairs the efficiency of the impact of the shoe. Accordingly, machines constructed so as to have the ore supplied by a "carrier" are preferable to those feeding according to the principle of a percussion or shaking table.

*Through the mistake of the draughtsman the vertical distance between the battery and concentrator floors has been exaggerated. This distance should be nine feet.



CHALLENGE ORE FEEDER.

TULLOCH ORE FEEDER.

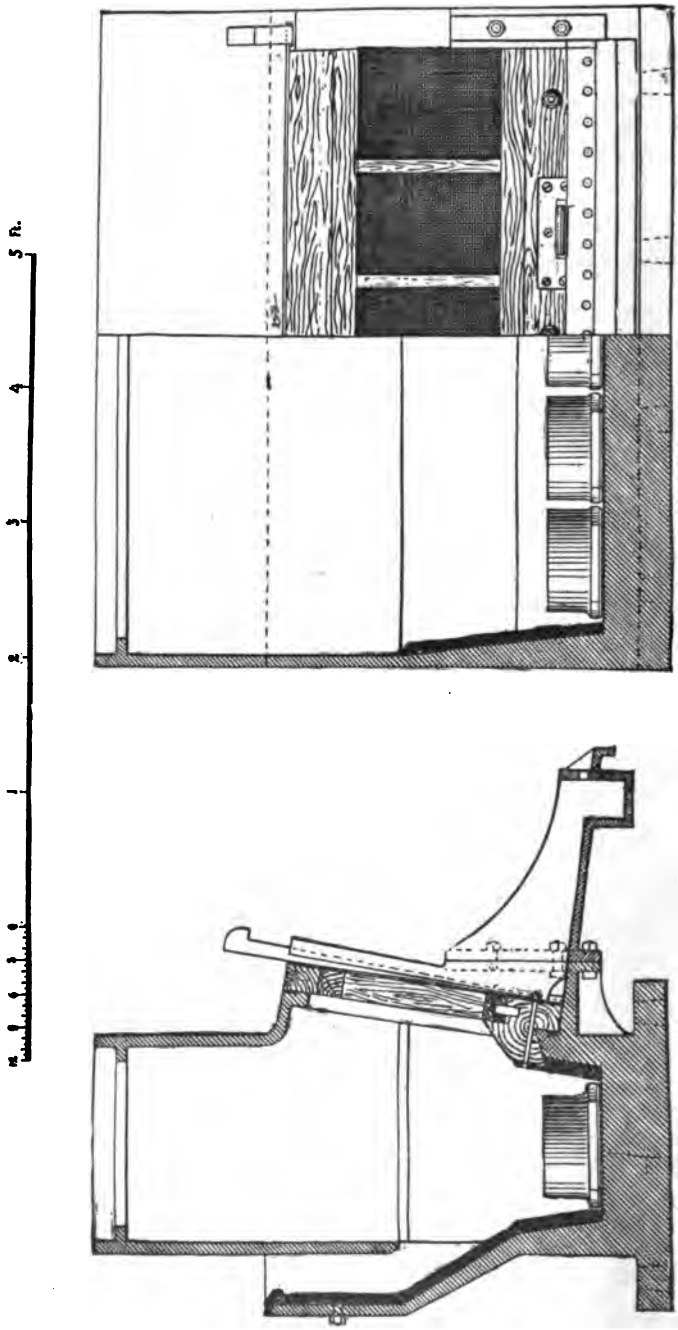


ROLLER SELF-FEEDER.

Their superiority is especially marked in the automatic feeding of wet, clayey, and other sticky ores, which adhere to the chute leading to the mortar. Hendy's "Challenge" ore feeder is, undoubtedly, the best self-feeding machine in use. The Tulloch, Stanford, and Roller feeders also give satisfaction for certain classes of ores. They are considerably cheaper than the Challenge and are often used for that reason. The Challenge ore feeder costs $250 in San Francisco. When packed for shipment it occupies twenty-three cubic feet and weighs seven hundred and fifty pounds.

CHALLENGE IMPROVED SUSPENDING SELF-FEEDER.

A convenient form of the Challenge ore feeder is the "Hendy Improved Challenge Suspending Ore Feeder." This arrangement does away with



MORTAR.

the carriages used for the ordinary Challenge feeder, thereby rendering the feed-side of the mortar more accessible. The machine is supported upon two parallel tracks, which rest upon the battery posts and upon standards placed against the ore bin.

MORTARS.

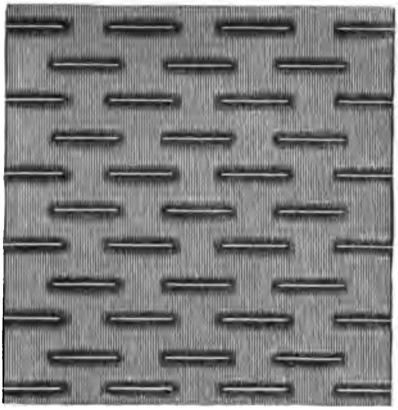
The width of the mortars is regulated according to the character of the ore. Narrow mortars accelerate the discharge of the pulp from the battery, but very rapid discharge is not always desirable when battery amalgamation is practiced. In hard, flinty ores, if the screens are brought close to the die, there is excessive breakage of screens, occasioning undue expense and loss of time in changing them. By raising the lower edge of the screens the liability of breakage may be reduced or obviated, but that increases the height of discharge, which reduces correspondingly the capacity of the battery and annuls the advantage aimed at in the use of narrow mortars. The feed-opening of the mortars should extend nearly their entire length and should be four inches wide, after allowing for the back-lining. Each mortar is provided with five inside cast-iron linings, which prevent its wearing. These linings are replaced when worn out. They last from six to nine months.

SCREENS.

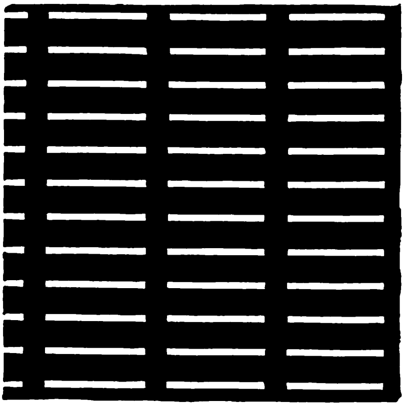
In California five different kinds of screens are used: Steel and brass wire, slot, and needle-punched sheet-iron, and tin. The slot and punched sheet-iron screens are made of soft, but tough, "Russia" sheet-iron. This iron has a planished, glossy, and smooth surface.

The numbers of sizes of the steel and brass wire screens correspond to the number of meshes per linear inch. The numbers and sizes of the needle-punched and slot screens correspond to the number of needles by which they are perforated. The width of the slots in slotted screens is equal to the diameter of the holes in a needle-punched screen of the same number. Numbers 5, 6, 7, 8, and 9 are the common sizes of slot and needle-punched screens. The slots are either horizontal or diagonal (angle slots). The lengths of the slots are usually one half, three eighths, or one fourth-inch. Some of the slots and punched screens are burred or indented and have their rough edges on the inside of the mortar. This prevents clogging of the screens.

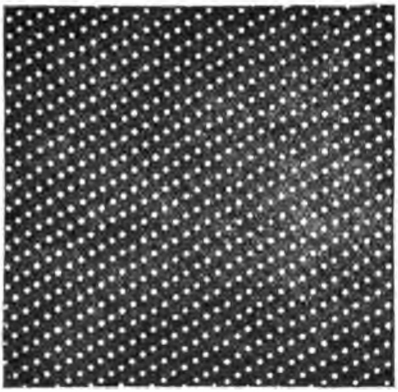
Tin screens, with the tin burned off, are used at the mills of the Plymouth Consolidated Company, Amador County. These screens are not as thick as the "Russia" iron, and consequently admit of more rapid discharge through perforations of the same diameter. They do not wear as long, however, as "Russia" iron screens. The sizes of brass wire cloth screens range from No. 16 to No. 60. The most common sizes are Nos. 30 and 40. No. 30 is made from No. 31 wire. No. 40 is made from No. 33 wire. This size can be purchased in San Francisco for about 36 cents per square foot. Each battery will require about three to four square feet. The prices in San Francisco for "Russia" iron slot and perforated screens are: Nos. 5, 6, and 7, 65 cents; Nos. 8 and 9, 75 cents; No. 10, 80 cents per square foot. Screens wear out near their lower edges. When one edge is worn the screen is turned upside down. Brass wire screens last from ten to fourteen days. Screens last longest with high discharge and wide mortars. One brass wire screen, No. 30, will last during the crushing of from one hundred and twenty to one hundred and forty tons of ore. Steel wire screens are not much used,



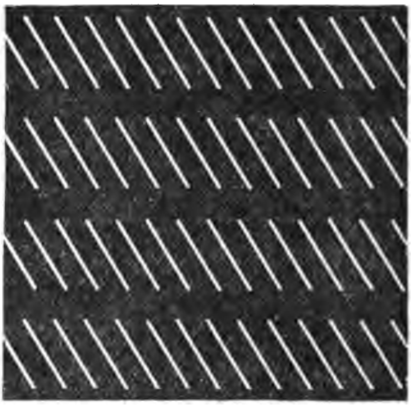
Burred Slot.



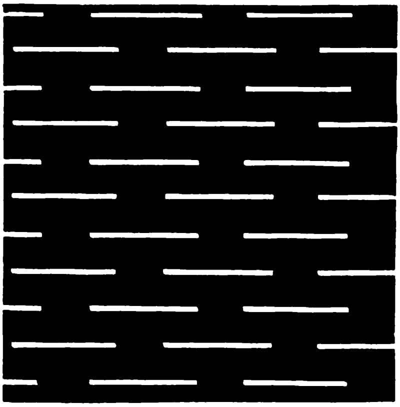
Horizontal Slot.



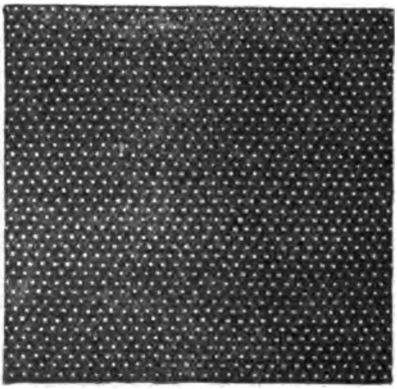
Needle-Punched.



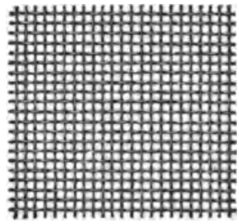
Angle Slot.



Horizontal Slot.



Needle-Punched.



No. 20 STEEL WIRE SCREEN.

owing to their tendency to rust. "Russia" iron screens last from fifteen to forty days; thirty days is about the average life of these screens. The area of discharge in the brass wire screens is greater than that of the slot or punched iron screens, and the pulp is more uniform in size than that discharged through the latter kind. The screens are set in recesses in the front part of the mortar and keyed. They are sometimes set vertically, but generally with an inclination of about 10 degrees. There should be a piece of heavy canvas (splash-board) across the mortar in front of the screens, against which the pulp splashes as it passes through the screens. The diameter of the orifices of the screens controls the fineness of the pulp. The proper size to which the ore must be stamped depends upon its character.

Stamping should not be carried farther than necessary for the liberation of the gold and sulphurets from the vein-stone. Where the gold is finely divided (in low grade ores generally) the stamping must be finer than where the gold occurs coarse. It is desirable to crush as coarse as possible when the sulphurets constitute an important part of the value of the ore, since too fine stamping produces an excessive quantity of pyritous slimes, thereby increasing the loss of the sulphurets. Furthermore, when stamping is carried too far, there is great danger of hammering the gold particles so as to render them less sensitive to amalgamation, and also to make them liable to escape as "float" gold. The great waste of power in "dead stamping" is attested by the fact that, generally, over 80 per cent of ore discharged through a No. 30 screen will pass through a No. 60 screen, and often as much as 50 per cent will pass through a No. 120 screen.

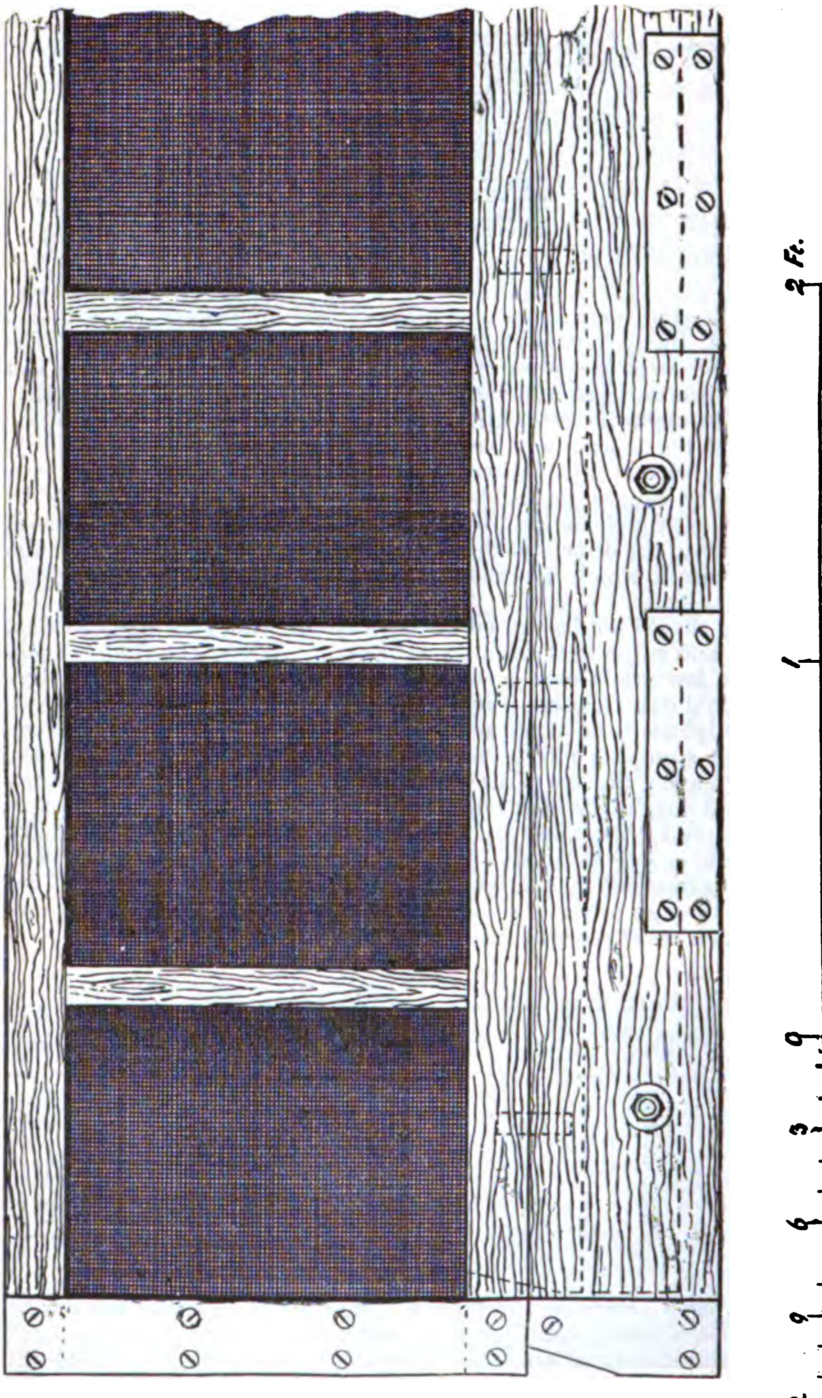
Table of Sizes, etc., of Screens.

No. of Needle.	Corresponding Mesh.	Width of Slot (Inches).	Thickness of Iron (Russian Gauge).	Thickness of Iron (American Gauge).	Wt. per Square Foot.
5	20	$\frac{29}{1000}$	No. 14	No. $23\frac{1}{2}$	1.15 pounds.
6	25	$\frac{27}{1000}$	No. 13	No. 24	1.08 pounds.
7	30	$\frac{24}{1000}$	No. 12	No. $24\frac{1}{2}$	0.987 pounds.
8	35	$\frac{22}{1000}$	No. 11	No. 25	0.918 pounds.
9	40	$\frac{20}{1000}$	No. 10	No. 26	0.827 pounds.
10	50	$\frac{18}{1000}$	No. 9	No. 27	0.735 pounds.
11	55	$\frac{16\frac{1}{2}}{1000}$	No. 8	No. 28	0.666 pounds.
12	60	$\frac{13}{1000}$	No. 8	No. 28	0.666 pounds.

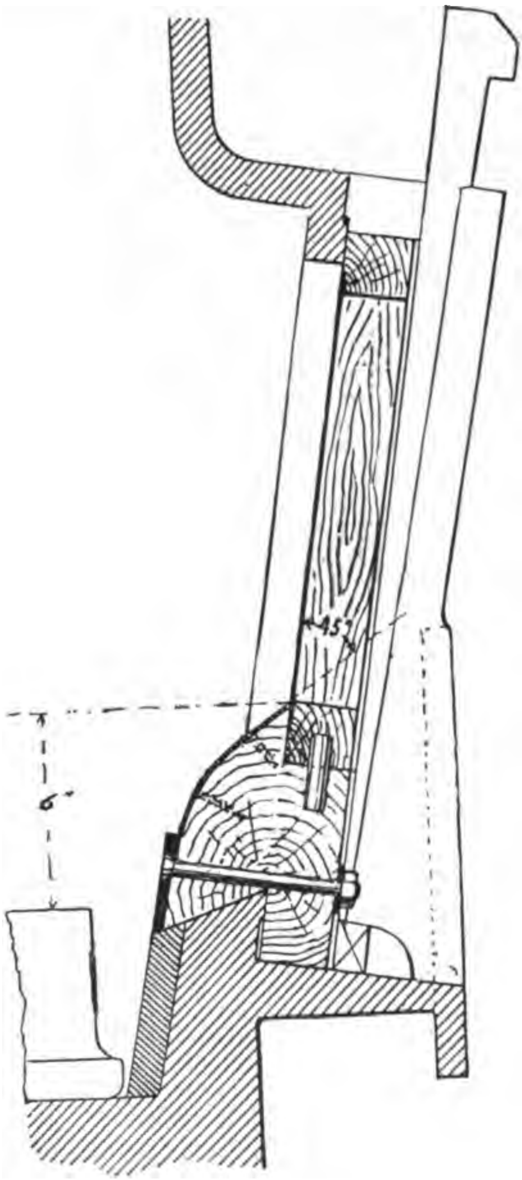
"Russia" iron comes in sheets twenty-eight inches by fifty-six inches, equal to ten and eighty-eight one hundredths square feet.

The measurements of some manufacturers differ somewhat from the above table.

Attwood's screen measure is very convenient for determining the sizes of the orifices of the screen.



BATTERY SCREEN FRAME.



ADJUSTABLE BATTERY SCREEN.

As dies wear down, wooden blocks (on which the inside plates are fixed), of less height, are substituted, thereby preserving uniformity in height of discharge.

DROP OF THE STAMPS.

The height of the drop is regulated with reference to the character of the ore, the speed, and the weight of the stamp. From four to nine inches are the extremes, and about six inches is about the mean height of the drop

for the California mills. Sufficient drop must be given to obtain a good splash. The soft ores and the highly sulphuretted ores should be stamped with a low drop.

ORDER OF DROP.

There is much diversity of practice in this respect. It is desirable to drop the stamps in such rotation as to insure an even distribution of the pulp on the several dies. Adjacent stamps should not drop consecutively, as this occasions accumulation of the pulp at one end of the mortar, in consequence of which the efficiency of the stamps at that end is reduced by having a decreased height of drop and a cushion which retards the pulverization of the ore. The stamps at the other end of the mortar have too little work, and are liable to "pound iron." The order of the drop, 1, 4, 2, 5, 3 (*i. e.*, first stamp drops first, this is followed by No. 4, that by No. 2, that by No. 5, and No. 3 drops last), seems to best fulfill the requirements. It gives a good splash, and satisfactory results in other respects.

The order 1, 5, 2, 4, 3, is also extensively adopted. There are several other orders of drops in use, but the two just mentioned are the best. Of these the order first given is to be preferred. Where the other orders are followed, one stamp is usually given greater drop than the others to counterbalance the piling of ore on one side of the mortar, which that order induces. In the following sketch of the battery, the stamps are numbered from one to ten, but the order of drop is 1, 4, 2, 5, 3.

DUTY OF STAMPS.

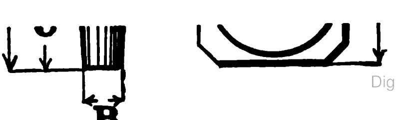
The number of tons of ore crushed per stamp will depend chiefly upon the weight of the stamp, the number of drops per minute, the height of drop, the height of discharge, the size of the screens, the width of the mortar, and, chiefly, upon the character of the ore. Hard ores and ores of a clayey nature (from the difficulty experienced in discharging the clayey pulp) decrease the duty of the stamps. Two and one fourth tons per stamp in twenty-four hours is approximately the average duty of the stamp in this State.

SPEED OF STAMPS.

Heavy stamps and stamps having high drops should have correspondingly low speed. With nine hundred to nine hundred and fifty-pound stamps, having six to seven inches drop, the speed should be from eighty-five to ninety-five drops per minute. With double-armed cams the speed must not be great enough to bring the cam into collision with the falling tappet, *i. e.*, the interval between the revolutions of the cam must be sufficient to give the tappet time to finish its drop. When the cam strikes the descending tappet, the shoe, boss, or tappet is often dislodged, and breakage is imminent. A fast drop produces a good splash, which is very desirable for battery amalgamation.

SHOES AND DIES.

Shoes and dies are either of iron or steel. Within a short time a great improvement has been made in the manufacture of steel shoes and dies. Formerly, owing to their tendency to chip and cup, their introduction met with but little success. In most mills, remote from foundries where transportation is an important item in the cost of shoes and dies, steel shoes and dies have replaced those of iron. Recently, chrome steel shoes and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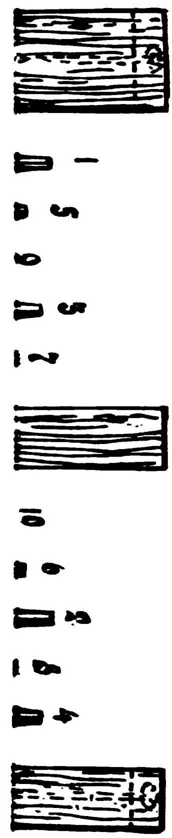

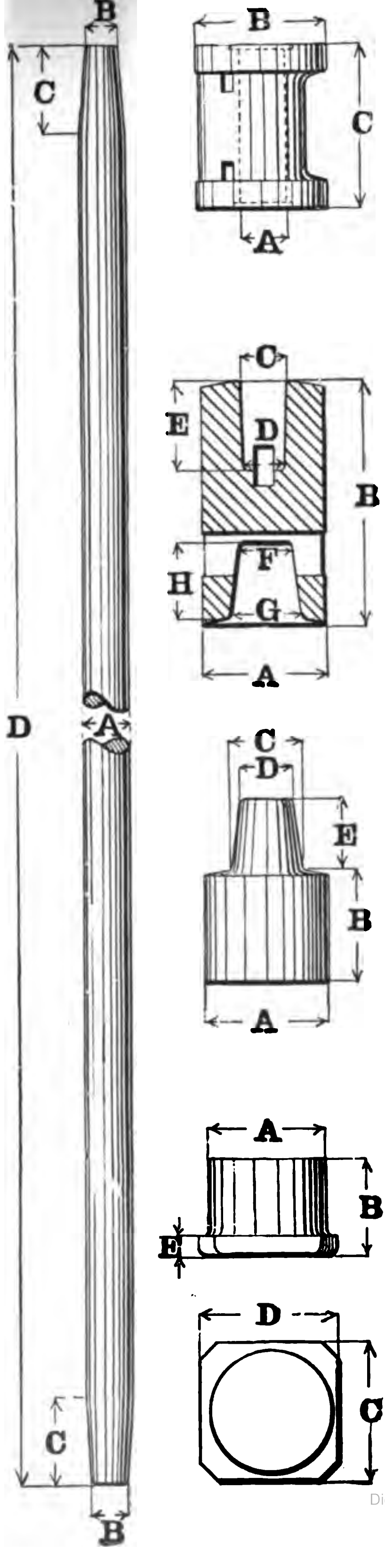

Stem, Tappet, Sockets, Shoes, Dies.

edge of the screens) as is compatible with the safety of the screens an
with successful amalgamation in the battery. (See previous descriptic
and diagram of adjustable screen frames, page 707.) To prevent poundir
of iron it is necessary to preserve more or less uniformity in the level
the dies. Should one die in the battery project much above the other
little or no pulp would remain upon it, and the shoe would, consequentl
drop upon the naked die.

dies have been introduced and have proved their superiority over most other kinds of steel used here. In some mills steel shoes and iron dies are used. The iron dies wear more evenly with steel shoes than the steel dies do. The life of steel is about two and one half to three times that of iron shoes and dies, and the cost about twice as great as those of iron. The mixture of steel (from the old chrome steel shoes and dies) with iron produces shoes and dies that wear considerably longer than those of pure iron, and may be advantageously introduced where there is no other disposition possible for the old steel, because of want of local facilities for the utilization of this residue. In many districts the old iron shoes and dies are sold to local foundries for from 1½ to 2 cents per pound.

The weights of the shoes bear a certain relation to the weights of the tappets, stems, and bosses. Chrome steel shoes made for stamps of eight hundred and fifty to nine hundred and fifty pounds, weigh from one hundred and forty-five to one hundred and fifty-five pounds, and measure about nine inches in diameter by seven and a half to eight inches long. The neck is from four and a half to five inches long, with a taper to correspond to the socket of the boss or stamp head. Iron shoes are usually from fifteen to twenty pounds lighter than the above weights. The chrome steel dies weigh from one hundred and ten to one hundred and twenty-five pounds, and measure (where shoes of the above dimensions are used) nine inches in diameter by four to four and a half inches in height, with a rectangular foot-plate ten and a half inches by nine and a quarter inches by one and one half inches thick. Iron shoes usually weigh from twenty to twenty-five pounds less than the above weights for steel.

LIFE OF THE SHOES AND DIES.

There are many conditions which affect the durability of shoes and dies, as, for instance, the hardness of the rock, the weight, speed, and height of the drop of the stamp, the manner of feeding the ore, etc. Iron shoes of good quality last from thirty to forty-seven days. Iron dies of good quality last from thirty to forty days. Old shoes wear usually down to one and a half to one inch in thickness and weigh about twenty-five to forty pounds. Old dies usually wear down to about one or one half inch in thickness, and weigh from twenty to fifty pounds. The consumption of iron or steel in shoes and dies depends upon the character of the ore crushed. Other conditions being the same, it will depend upon the coarseness of the stamping and the height of discharge. Dies wear less rapidly than the shoes, as they are protected by the thickness of the pulp, which covers them to the depth of from one and one half to three inches. But while the actual wear of dies is less than that of the shoes, the life of the dies is shorter than that of the shoes, owing to the fact that the shoes have several inches of greater length of wearing part than the dies. The consumption of iron for shoes and dies per ton of ore crushed is from one and a half to three pounds. To obtain the maximum crushing capacity of the battery, the dies must be kept as high (with reference to the lower edge of the screens) as is compatible with the safety of the screens and with successful amalgamation in the battery. (See previous description and diagram of adjustable screen frames, page 707.) To prevent pounding of iron it is necessary to preserve more or less uniformity in the level of the dies. Should one die in the battery project much above the others, little or no pulp would remain upon it, and the shoe would, consequently, drop upon the naked die.

CAMS, STAMP HEADS, AND STEMS.

Cams and stamp heads ought to last several years. They are usually broken through carelessness. The stems break at the socket of the stamp head. Stems are reversible; when broken they may be swedged or planed down and additional lengths welded on when necessary.

TAPPETS.

The revolving cam, besides lifting the tappet imparts to it a rotary motion, which, to some extent, is communicated to the stamp in dropping. This produces a grinding effect, which assists in crushing the ore. The rotation of the stamp performs a far more important office in equalizing and, consequently, diminishing the wear of the shoes and dies. When there is but little grease on the tappet it makes a complete revolution in from four to eight lifts by the cam. In falling, of course, but a small part of the rotary motion imparted to the stamps in rising is retained. When there is much grease on the tappet or cam, or when the tappets have so worn that the face of the cam strikes a grooved instead of a level face on the tappet, the rotary motion is greatly impaired. Tappets last for several years, from four to five years being their usual life. Sometimes they are broken by being too tightly keyed. When their faces are worn they are planed down. Tappets are reversible, so that when one face has been worn as far as possible, the other face is placed downwards. Tappets are usually of steel, and weigh about one hundred and twelve pounds when nine hundred-pound stamps are used.

MILL WATER.

Battery Water.—The amount of water fed to the battery depends upon the character of the ore and the size of the screen. Clayey and highly sulphuretted ores require the maximum amount of water. The amount of water used per ton of ore stamped varies from one thousand to two thousand four hundred gallons. The mean amount used per ton of ore stamped is about eighteen hundred gallons. From three fourths to one and a half miner's inches per battery should be provided.* In winter, when the battery water is chilly, it should, when possible, be heated to tepidity, as this promotes amalgamation. A high temperature should be avoided, as it renders the quicksilver too lively.

Concentration Water.—The feed water required for concentration is from one to two gallons per minute for each concentrator. The wash water for each concentrator is about one half to one gallon per minute. Total mill water required for a forty-stamp gold mill with sixteen concentrators, varies from eight to sixteen miner's inches—twelve inches is about the average. Where steam power is used one miner's inch of water supplies the boilers.

AMALGAM.

In battery amalgamation the largest part of the amalgam is caught upon the inside plates. But when the gold is coarse the percentage of amalgam caught in the battery (upon the inside plate, generally) is greater than when the gold occurs finely divided in the ore. The width of the mortar, the height of the discharge, and the fluidity of the amalgam also influ-

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* A miner's inch of water in twenty-four hours is about sixteen thousand eight hundred gallons.

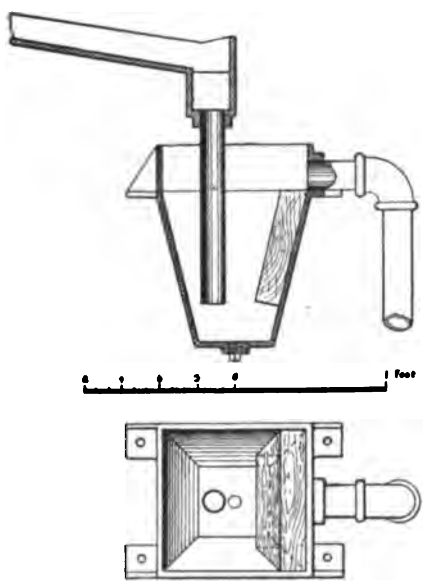
ence the ratio between the quantity of amalgam saved in the battery and that saved upon the outside plates. Narrow mortars, low discharge, and the feeding of much quicksilver, which produces a fluid amalgam, decrease the percentage of the battery amalgam. Sometimes, from these causes, more of the amalgam is caught without than within the battery. Generally, however, from 50 to 80 per cent of the amalgam saved comes from the battery.

VALUE OF THE AMALGAM.

The amalgam from the inside plates, from the linings of the battery, etc., invariably contains more gold than that from the outside plates. The value of the amalgam increases with the coarseness of the gold in the ore. Finely divided and alloyed gold yields comparatively poor amalgam.

At the Original Empire and the North Star Mills in Grass Valley, the value of the plate amalgam averages about $4 50 per ounce, and the value of the battery amalgam about $8 50 per ounce. Probably 70 to 85 per cent of the gold derived from the amalgam comes from the battery amalgam. Amalgam from ores of the same mine sometimes varies greatly in value in different clean-ups.

BATTERY AMALGAMATION.



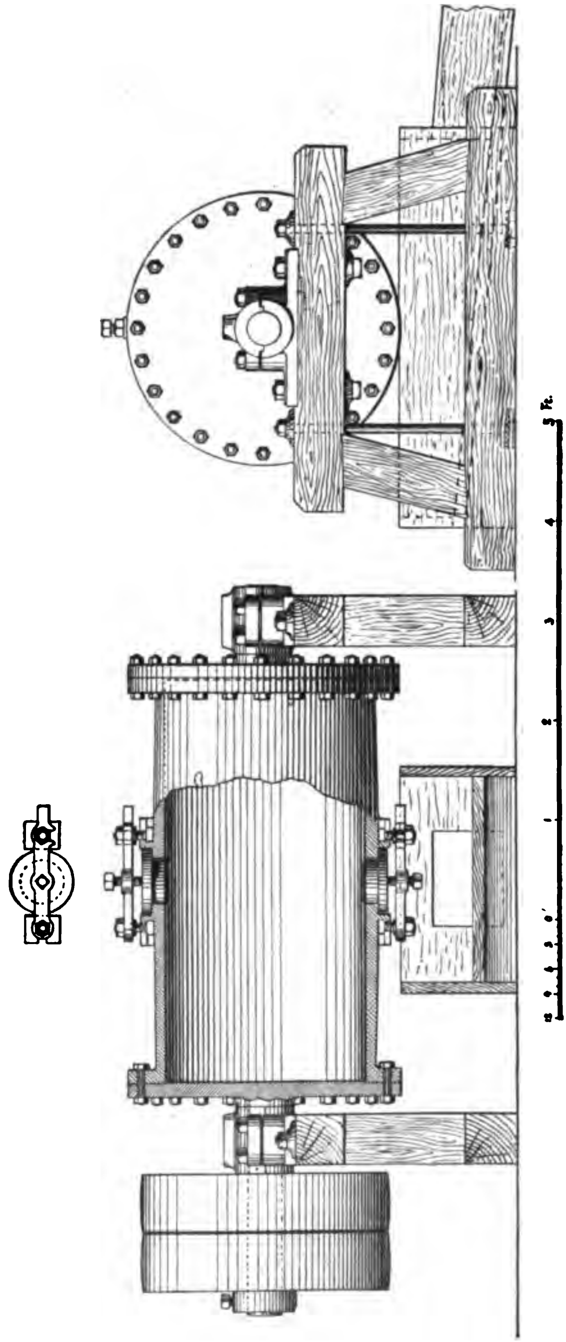
Amalgam Trap.

This trap is placed at end of sluice plates to catch amalgam, quicksilver, etc., that escape from above.

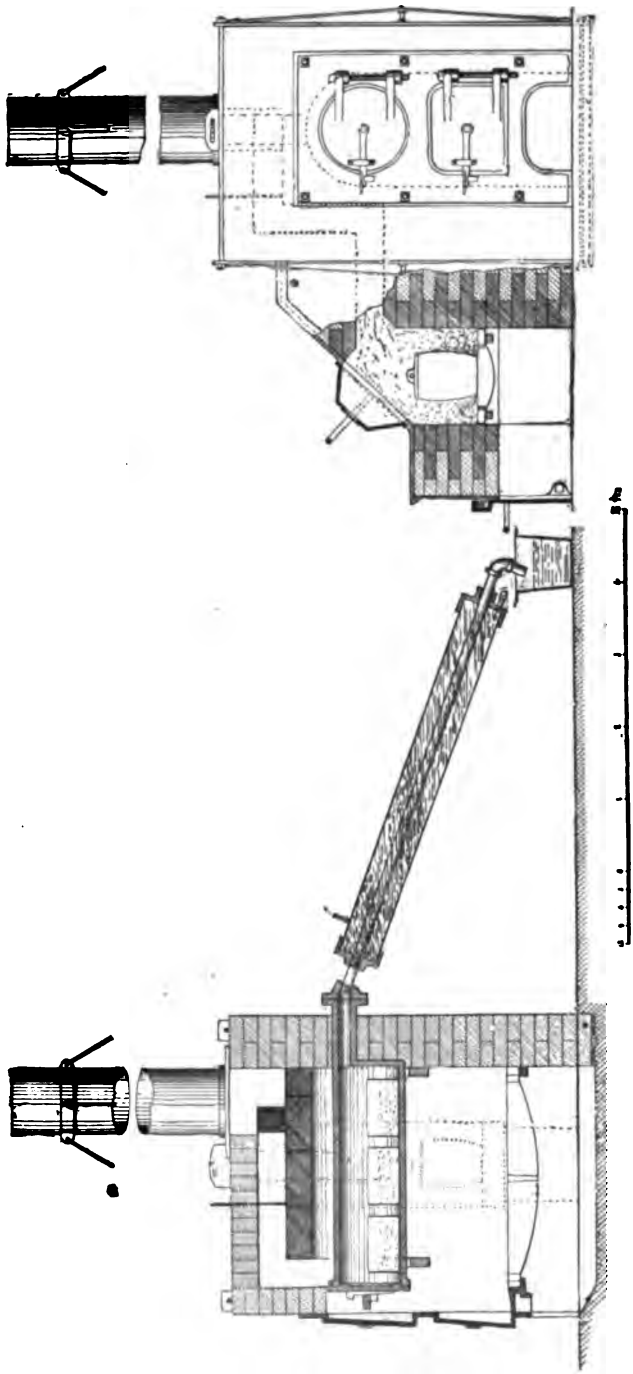
In nearly all of the mills of this State battery amalgamation is practiced Where the percentage of sulphurets is excessive, however, battery amalgamation is not advisable.

THE CLEAN-UP.

The frequency of the times of the clean-up depends upon the richness of the ore and upon the local practice in this respect. The outside plates,



CLEAN-UP BARREL.



RETORT AND MELTING FURNACE.

i. e., the outside battery plates, the apron plates, and the sluice plates are usually cleaned up every twenty-four hours. The amalgam and the "skimmings" are ground with the addition of quicksilver in the clean-up pan, in order to soften and clean the amalgam. The redundant quicksilver is expressed and the amalgam retorted in conjunction with the amalgam from the general clean-up. The clean-up of the outside plates requires from ten to fifteen minutes for each battery. The general clean-up of the mill is usually once or twice a month. Two batteries are hung up, the outside battery plates and the screens removed, and the inside plates and the dies taken out. These plates are laid over the sluice plates and the amalgam scraped off. Care must be observed to prevent the plates being scratched. Amalgam will sometimes be found adhering firmly to the linings of the mortar and to the dies. All the amalgam obtained is cleaned in the clean-up pan. In large mills the use of the barrel and clean-up batea is to be recommended.

The "headings," composed of pulp and uncrushed ore, quicksilver, sulphurets, pieces of iron, steel, etc. (the steel and iron are taken out with a magnet), amounting to two or three pailfuls, are run through one of the batteries, through which the headings from the other batteries are likewise passed. This battery is cleaned up in the manner above described, a part of the worthless material removed by panning with a miner's common gold pan, and the remaining material is then run through the clean-up pan. After one or two hour's grinding, with the addition of quicksilver, in the clean-up pan, the refuse matter is run off and the amalgam and the quicksilver collected. Three men can clean up a forty-stamp mill in from five to seven hours. The loss of from five to seven hours for two batteries is consequently incurred by a general clean-up. At this time advantage is taken of the stoppage of the battery to make needed repairs and to change the shoes, dies, screens, etc., if required.

It takes from two to four hours to retort the amalgam in the silver retorts which are used in large mills. Small mills use the cup-shaped retort. It takes about one to two hours to melt the gold from the retorted amalgam. The melted gold is poured into molds of the suitable dimensions. Bullion assays should be made to ascertain the fineness of the gold bar.

CLEAN-UP ROOM.

This room should be as near as possible to the battery. The floor should be of cement to prevent loss of amalgam and quicksilver. There should be two cast-iron tanks four feet long, three feet wide, and three feet deep, to prevent loss of material and leakage in panning out. In one corner of this room is placed a small clean-up pan two and one half feet in diameter. This pan is provided with drags of iron or hard rock. The use of the pan has been described before.

BATTERY DISCHARGE.

In battery amalgamation the height of the discharge, *i. e.*, the vertical height of the lower edge of the screen above the die, is governed by the width of the mortar. Narrow mortars require a higher discharge than wide mortars, in order to avoid breakage of screens, and to prevent scouring of the inside copper plate. It varies from four to nine inches, the mean being about six or seven inches. A uniform height of discharge should be

observed. As the dies wear down the edge of the screen is lowered correspondingly. The device to regulate the height of the discharge is shown in a drawing on page 707.

With ores quickly crushed and readily discharged, it is necessary to raise the screen, *i. e.*, to increase the height of the discharge, in order to retain the pulp in the mortars sufficiently long for its proper amalgamation. Mortars for California gold mills have almost invariably but a single discharge. The sentiment of millmen is with remarkable unanimity opposed to double-discharge mortars. The objections urged against double-discharge mortars are:

First—The inconvenience in the arrangement of the copper plates when adapted to double-discharge.

Second—The necessity of using too much battery water (especially where concentration follows).

Third—The ore is not given time for proper amalgamation in the battery.

While these objections are more or less valid, and, it is unquestionably true, that some of these conditions do militate against the successful use of double-discharge mortars, it is, nevertheless, the fact, that some of the advantages of mortars of this class greatly commend their use for certain classes of ores.

Where ores are very heavily sulphuretted and, consequently, can not be amalgamated in the battery, double-discharge mortars may be advantageously used. Their use is especially desirable where the ores contain brittle sulphurets, which, from being too long subjected to stamping, are liable to be slimed.

Stamps crush ores of most classes faster than the screens discharge the pulp. Much of the pulp, from lack of adequate facilities of discharge, is retained in the mortar and subjected to continued pulverization, with the result that a great part of it (especially the sulphurets) is slimed, *i. e.*, reduced to an excessive degree of comminution; in consequence there may be considerable loss resulting from the well known tendency of the slimes to flow off in spite of all endeavors to settle them. Repeated stamping of the fine gold particles may likewise produce "float" gold, which is difficult and indeed at times impossible to save. Gold subjected to heavy pounding is not easily amalgamable.

PLATES.

Silver-plated copper has almost everywhere superseded the ordinary amalgamated copper plates. These are more easily kept clean, as they are not so readily affected by impure battery water or exposure to the air. To insure good amalgamation the plates must be clean and bright. Grease or oil in the battery water prevent proper amalgamation. The presence of these very deleterious substances should be carefully avoided, and if present must be counteracted by the introduction into the battery of a saturated solution of wood ashes. Cyanide of potassium in dilute solution is used to promote amalgamation. The practice of using cyanide of potassium is less common than formerly. One or two pounds will be sufficient to clean the plates of a forty-stamp mill for one year. The copper plates are not generally resilvered, as a coating of amalgam forms upon them which is very effective in saving gold. This layer of amalgam should not be allowed to accumulate to too great a thickness, but should be removed occasionally by "sweating" the plates. An improved method in use at the North Star Mill is to immerse the plates in boiling water until the amalgam is softened sufficiently to be easily scraped off. Where the pulp carries but little amalgam or quicksilver, the silver-plating is soon worn out.

Where mills have occasion to resilver their copper plates often they should have a plant for that purpose. Such a plant to silver six by four feet of copper plates costs about $1,200—about $1,100 of this is expended in the preparation of the solution. This is prepared by dissolving chloride of silver in a solution of cyanide of potassium. The electrolytic action is produced either by batteries or by dynamos. The action of the latter is more expeditious. A dynamo for this purpose costs about $225. About one and one eighth horse power is required to run them when used. The quantity of silver taken from the solution must be replaced by the addition of equivalent silver anodes. The cost of silver-plating is but little more than the cost of the silver. One ounce of silver per square foot of copper is the usual amount used.

The copper plates should be annealed and softened so as to possess an absorbent surface. They are usually about one sixteenth of an inch in thickness and weigh about three pounds per square foot. They cost in San Francisco at this date 26 cents per pound. Silver-plating costs $2 50 per foot when one ounce of silver, which is the usual quantity, is used. That makes the total cost per square foot about $3 28. The sizes of sheet copper are thirty inches by sixty inches, forty-eight inches by seventy-two inches, forty-eight inches by ninety-five inches, and six inches by one hundred and twenty inches. The widths of sluices, etc., should be made with reference to the size of sheet copper in market in order to avoid waste of copper in cutting.

There is a constant absorption of amalgam by the plates. The amalgam replaces copper or forms a layer upon it too hard to be rubbed off. At Grass Valley after a run of a year or two the outside battery plates and apron are sweated. Notwithstanding the fact that the plates were quite well cleaned every day the sweating of the outside battery plates and the aprons from four batteries of the Empire Mill, yielded $19,000 worth of amalgam. This was the result of absorbed amalgam after one and a half year's run. The ore during this period averaged about $18 per ton in free gold.

GRADES OF PLATES.

The grade or inclination of the inside copper plates is very variable. The grade or inclination given to outside plates varies with the amount of sulphurets in the ore, the amount of water used, and the fineness or coarseness of the gold. It is necessary to give the plates sufficient grade to prevent the deposition of pulp upon them. Heavily sulphuretted and coarsely crushed ores require the maximum grade. The frame supporting the plates should be so constructed as to admit of the grade being adjusted conformably to the requirements of the ore treated. Experiments will show the proper grade for the ore in question. The usual grade for the outside battery plates is from one and a half to two inches per foot.

The usual grade for the apron plate is from one half to one and three fourths inches per foot. One and one half inches is about the mean grade.

The usual grade for the sluice plates is from one and one fourth to one and one half inches per foot. In most mills the sluice plates are much narrower than the upper plates. This is a reprehensible system, since the depth and flow of the water become so great, being confined to the narrower channel, that some of the gold carried by the deep and swift current entirely escapes contact with the plates. It is preferable to make the sluices the same width as the aprons.

For the treatment of most ores steeper grades for the plates, with less water, are to be preferred. By this plan the gold, etc., is rolled along and

brought into contact with the plates. The shaking tables, described in the specifications, are an important adjunct to the system of amalgamation plates. They should be of the same width as the sluice plates, but set at a slightly less grade, the propulsion of the particles being assisted by the oscillatory motion imparted to the plates. There should be one or two drops along the line of plates from two to three inches in height. This gives the gold an opportunity of coming in contact with the plates. It will be found that a crater-like deposit of amalgam accumulates around the point of impact of the dropping pulp.

The frames of the plates (with the exception of the battery plate, which is supported on a casting bolted on to the mortar) should rest upon bearings independent of the framework of the battery, so as to avoid the jar which would otherwise ensue. The plates are held in the framework by wooden cleats.

QUICKSILVER.

Quicksilver is charged every half hour or so into the mortars. The quantity added depends upon the quantity of gold in the ore, as well as upon the physical character of the gold. Finely divided gold requires more quicksilver than coarse gold. Sulphuretted ores also require larger quicksilver charges than ores which contain no sulphurets. Ores of that character have a scouring effect on the plates, and also carry off, as loss, much quicksilver. The consistency of the amalgam on the outside copper plates indicates whether or not sufficient quicksilver has been added to the battery. When the amalgam is hard and dry more quicksilver must be added, but when it is too fluid to adhere to the plates the quantity of quicksilver charged must be diminished. The amalgam should be sufficiently pasty in consistency to adhere to the plates, but not fluid enough to roll off the plates. From one to two ounces of quicksilver are added to the battery for each ounce of free gold contained in the ore. The price of quicksilver fluctuates greatly; at present it is about $41 per flask. The net weight of quicksilver in the flask is seventy-six and one half pounds. At this figure quicksilver costs 53½ cents per pound.

QUICKSILVER LOSS.

The loss of quicksilver per ton of ore is very variable. Where battery amalgamation is practiced, heavily sulphuretted ores, especially ores carrying galena and arsenical pyrites, occasion a large loss of quicksilver. Loss of gold undoubtedly accompanies the loss of quicksilver, but not to the extent asserted by many millmen. The loss of quicksilver at the Empire and North Star Mills exceeds that of any mills in the State, but, per contra, there are few mills that save as high a percentage of the gold contained in the ore as these mills do. The loss at these mills is often as great as one ounce per ton crushed. The loss of quicksilver in other districts varies from one ounce per five tons of ore crushed to one ounce per one and one half tons of ore crushed. One ounce per two tons of ore crushed (one pound for thirty-two tons) is about the mean quicksilver loss for the mills of the State. A small part of this loss occurs through carelessness in handling the quicksilver, and in retorting. Even after retorting the retorted gold often contains some quicksilver which has not been sublimed during the operation of retorting. This quicksilver is lost in the succeeding operation of melting the gold. The quicksilver loss occurs generally through its being "floured" and floated off with the water in extremely finely divided particles.

CONCENTRATORS.

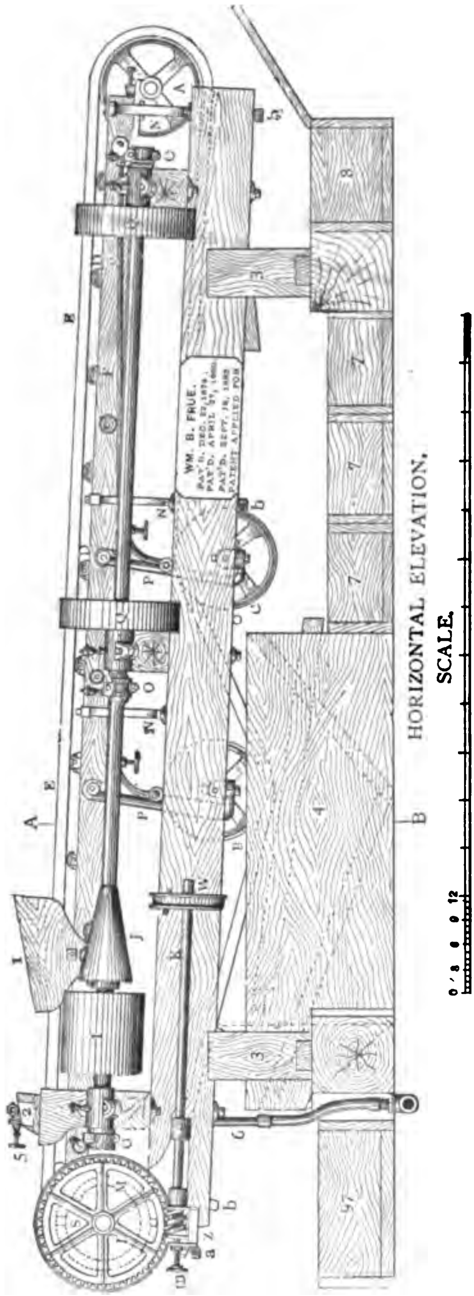
From the distributing box at the end of the line of the copper plates, the pulp is conveyed through two-inch pipes to the concentrators. The concentrators have various devices for saving the amalgam, free gold, and quicksilver that may not have been caught by the preceding appliances; but the pulp, when it comes to the concentrator, ought not to carry these substances. The quicksilver, that because of careless or imperfect amalgamation, finds its way to the belt of the concentrators, is lost by volatilization in the roasting of the concentrates, in their treatment by the Plattner chlorination process. The amalgam and free gold, when coarse, are but imperfectly recovered by the chlorination process. It is, therefore, important to save these substances, as above stated, before they pass to the belts of the concentrators.

There is no preliminary sizing of the particles of ore in our gold mills, and, consequently, the conditions essential to perfect concentration are lacking. Despite this serious disadvantage, some of the concentrators (the Frue and Triumph machines, especially) succeed in obtaining clean concentrates, with but a small loss of the auriferous sulphurets. There are several concentrators in use in this State, the most important of which are the Frue, the Triumph, the Golden Gate, the Duncan, and the Hendy pan. The Triumph and the Frue machines are at present by far the most popular concentrators in use in California. Both of these machines are excellent concentrators. Each has features of superiority as compared with the other, and each has its special advocates among millmen.

Briefly described, these concentrators (the Frue and the Triumph) have an endless traveling rubber belt, near the head of which the pulp is fed. The belts are carried upon a supplementary frame mounted upon springs. The table is slightly inclined, and the upper surface of the belt travels up hill. The heavier particles (sulphurets) settle on to the belt, and, adhering to it, are carried over the head of the table and deposited in a tank or wooden box below the table. The traveling belt is immersed on its return under the table to a depth of about half an inch in water, which is kept in the tanks to remove the sulphurets adhering to the belt. The deposition of the sulphurets is also assisted by a jet of water, which plays against the belt as it passes over the tanks. About one half to one gallon of water per minute for each machine is used for this purpose. There is a patented arrangement used at the Empire Mine for removing the sulphurets from the belt and depositing them in a convenient place for shoveling into wheelbarrows.

The specifically lighter particles (gangue) are carried downward by the current and pass as "tailings" to the blanket sluices outside of the mill. A reciprocating motion is imparted to the supplementary frame by which the specifically lighter particles are kept in agitation and suspension; while those of greater gravity settle and adhere to the belt. The specifically lighter are carried off by the current as above described.

To facilitate the settling of the heavier particles and to clean the sulphurets from all gangue, the battery pulp is diluted by the addition of a small quantity of feed water distributed on the belt near the head of the concentrator. This quantity of feed water varies from one to two gallons per minute for each machine. There is a separate tank outside of the mill into which the overflow water from the tanks below the belt is conducted and the fine sulphurets carried in suspension by this water are collected. These fine sulphurets are generally much richer than the coarse sulphurets.

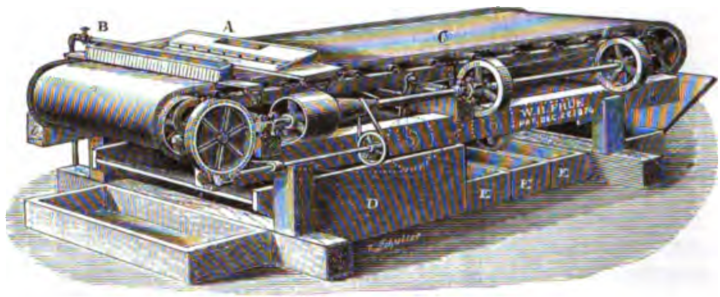


HORIZONTAL ELEVATION.

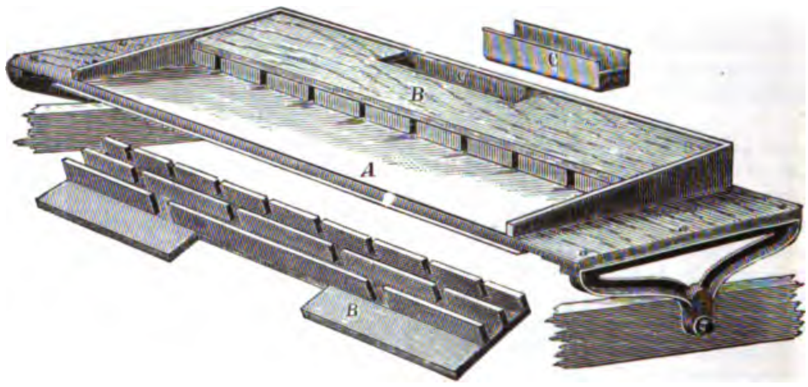
SCALE.

FRUE VANNER.

The pulp should be evenly distributed over the concentrators from a depth of five sixteenths to one half inch. This is called the load. The consistency of the pulp should be carefully observed and regulated to attain good results. This is effected by an increase or diminution of the feed water of the concentrator.



FRUE VANNER.

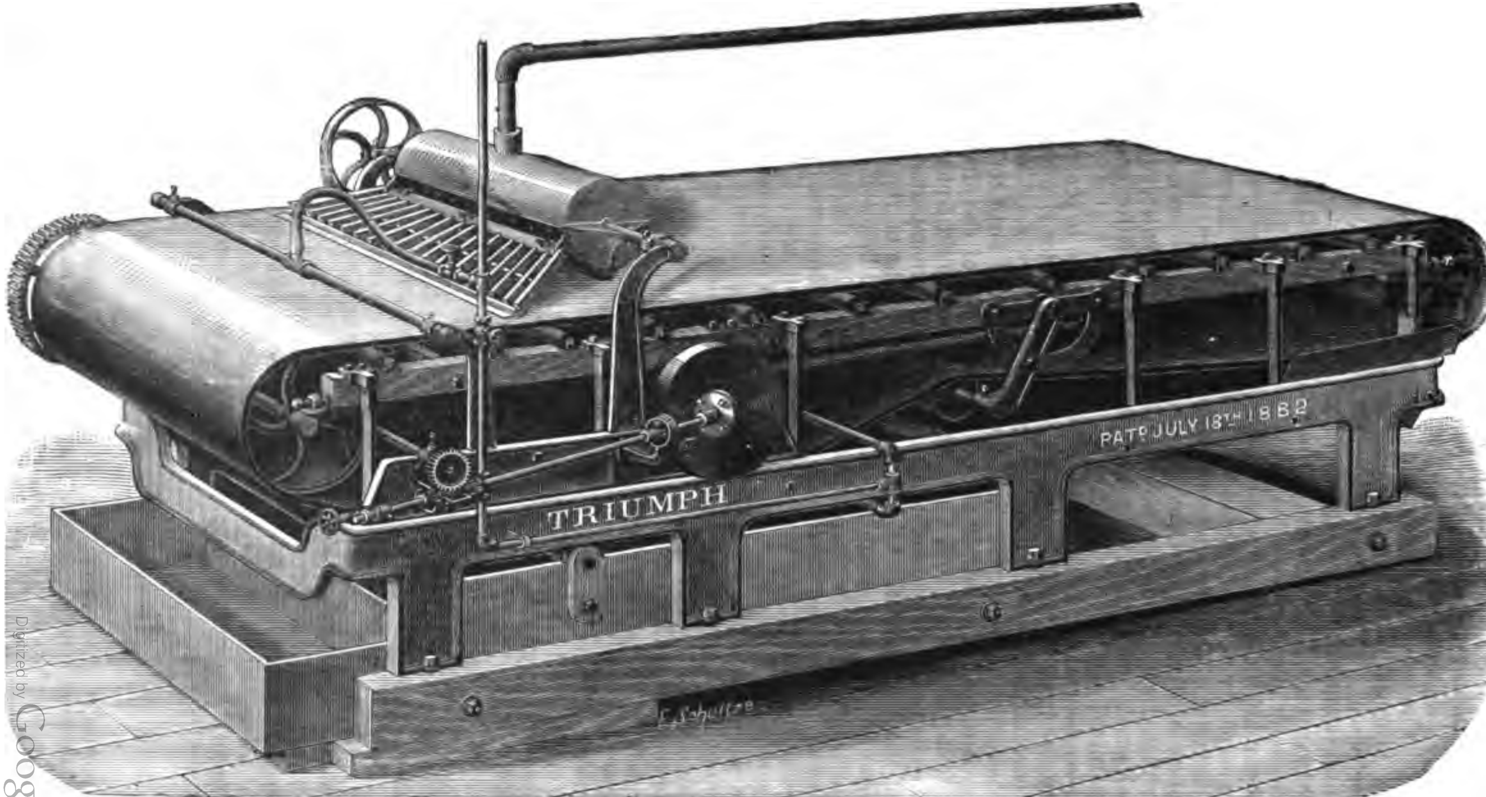


SPREADER—FRUE VANNER.

The Frue vanner has a distributer or spreader, as shown in the above cut. *C* is a copper well. It is shown separate and also in place in the spreader. The pulp from the battery passes into this well and a portion of the amalgam and quicksilver escaping from the battery plates, etc., is saved. *B* is a movable top board. *A* is often covered with a silver-plated copper plate.

The Triumph concentrator has also an amalgam and quicksilver saving apparatus. It consists of a cylindrical trough or bowl, into which the pulp passes before issuing on to the distributer. This arrangement is shown in place on the concentrator. From fifteen to twenty pounds of quicksilver are placed in the trough or bowl. There is a set of revolving blades in the trough, which stir up the pulp and permit the quicksilver and amalgam to settle, while the lighter pulp is floated over to the distributer and thence passes to the belt.

The Frue vanner has a side oscillation of one inch, given by a crank shaft, making from one hundred and eighty to two hundred revolutions per minute. The belt of the Frue vanner travels from three to twelve feet per minute.



TRIUMPH CONCENTRATOR.

The Triumph concentrator has an end shake or oscillatory motion, imparted by a driving pulley running two hundred and thirty revolutions per minute. The belt travels from three to four feet per minute. The weight of the Triumph concentrator boxed is two thousand two hundred and seventy pounds. The weight of the belt included in the above is two hundred and twenty pounds. The weight of the heaviest part of the machine is eighty pounds. The weight of the Frue vanner boxed is about one thousand nine hundred pounds.

These machines cost about $550 in San Francisco.

The capacity of these machines varies with the character of the ore. Ores carrying a large percentage of sulphurets, or carrying sulphurets in a fine state of division (pyritous slimes), require more concentrators than ores which have a smaller percentage of sulphurets, or sulphurets of a coarser grain. As a rule, two concentrators are used for each battery of five stamps.

The concentrating floor should be sufficiently large to provide a space of twenty feet long by ten feet wide for each concentrator. Where space has to be economized these figures may be reduced somewhat. When a double row of concentrators is used, they should be placed head to head, in front of the batteries. The heads of the concentrators of the first row are set away from the battery, and a passage way of five to six feet is left between their heads and the heads of the second row of concentrators. A passage way of three feet should be left between the sides of the concentrators. The level of this floor should be at least nine feet below the lower end of the battery floor, in order to provide head room below the pipes which convey the pulp from the distributing box to the concentrating floor. The grades of the table, the speed with which the belt travels, the number of oscillations of the machine, the quantity of water fed to the belt, the quantity of pulp—*i. e.*, the load it carries—should be adjusted to conform to the requirements of the ore treated. These conditions must be strenuously maintained, in order to secure good results in concentration. To secure regularity in the speed of the belts and in the number of shakes, the concentrators must be run by power independent of the other machinery. At the most approved water power mills there are special wheels for the concentrators. When the concentrator is connected with the main driving shaft of the mill, the stoppage of any of the other machinery, as rock breakers, batteries, etc., has a disastrous effect upon the work of the concentrator.

LABOR FOR CONCENTRATORS.

Three men—one head concentrator and two assistants—can easily attend to sixteen concentrators of a forty-stamp mill per twenty-four hours. The duty of the head concentrator is to repair the machines, oil them, etc., and also to attend to the machines while the assistant is raking out and removing the concentrates to the sulphuret room.

In a large mill, having eighty or more stamps, with thirty-two or more concentrators, for example, it is preferable to have one man per shift to attend solely to the adjustment of the machines, and an engineer to make repairs for all machinery about the mill. One roustabout can remove the accumulated sulphurets.

CONCENTRATES OR SULPHURET ROOM.

Adjoining the concentrating room and on a level with it, on the sunny side of the building, where practicable, there should be a room in which to store the sulphurets. It should have a concrete floor, slightly inclined

towards the center so as to drain the water from the concentrates. It should also have glass windows to assist in drying the concentrates by solar heat.

TREATMENT OF THE CONCENTRATES.

The concentrates are treated by the Plattner chlorination process. This consists in roasting the concentrates in reverberatory furnaces to expel the sulphur, arsenic, and other volatile, deleterious substances. Salt is added as the roast nears completion. The thoroughly roasted (dead roast) concentrates are charged into impregnation vats, through which chlorine gas is passed. The chlorine gas is generated by the reaction of sulphuric acid upon salt and binoxide of manganese. The chlorine gas in the nascent state attacks the gold, forming with it terchloride of gold. Then water is added to the vats, by which the terchloride of gold is leached out. The lixivium is run into precipitating tanks, where, by the addition of a solution of sulphate of iron, the gold is precipitated. This gold is collected upon filters thoroughly washed, dried, and melted. Chlorination gold averages from 998 to 999½ fine. When the concentrates are argentiferous, as is often the case (rarely containing more than ten to fifteen ounces of silver per ton), the silver, which has been converted into the chloride of silver by the roasting with salt, is leached out by hyposulphite of soda (or of lime), the lixivium run into precipitating tanks, where the silver is precipitated by the addition of a solution of polysulphide of sodium (or of calcium). The sulphide of silver is collected upon filters, washed and dried, and then reduced to the metallic state. A chlorination plant, with a capacity of six tons per twenty-four hours, costs from $6,000 to $7,000. It costs with such a plant about $10 per ton to treat the concentrates. About 92 per cent of the assay value of the gold contained in the concentrates is recovered. Some of the large mills have their own chlorination works, but most of the mills have the concentrates treated at custom chlorination works situated in the district. Most of the important mining districts have custom chlorination works. These works charge about $20 per ton to treat the concentrates and guarantee a return of 90 to 92 per cent of the assay value of the gold in them.

BLANKET SLUICES.

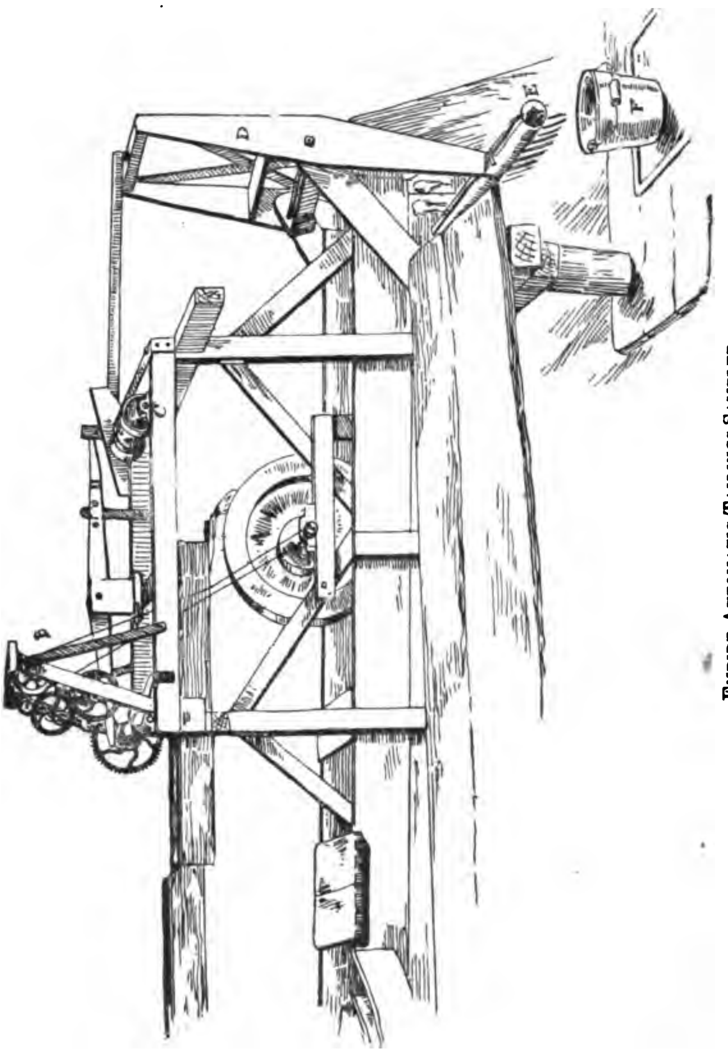
The length of the blanket sluices outside of the mill is governed by the value of the tailings from the mill. From one hundred to two hundred feet usually suffice. These sluices have a grade of from one inch to one and a quarter inches per foot. The sands collected on these blankets are usually ground in a pan used for that purpose. These pans have a diameter of from three and a half to four feet and are essentially like those used in silver mills.

TAILINGS.

The pulp leaving the sluices is called the "tailings" of the mill. In order to keep a proper supervision over the mill "tailings," samples ought to be taken several times during the day and night and the value of the tailings ascertained. Millmen are exceedingly remiss in this regard, as very few mills have any systematic method of sampling and assaying of the tailings.

At the Original Empire Mill there is an automatic tailing sampler, the invention of Mr. Starr, the Superintendent.

This machine can be regulated to take samples as frequently as desired. The samples are taken every hour, and the pulp assayed three times a



Empire Automatic Tailings Sampler.
Overshot water wheel actuates wheels B, which, at stated intervals, operates frame D, tailing sample passing through E to F.

week. The samples are examined carefully to ascertain to what the loss is to be ascribed. Microscopical examinations of the sands should be made occasionally, to ascertain if a perfect liberation of the particles of gold from the gangue has taken place. Such thorough sampling is a check upon the men at the concentrators, and causes them to be alert and zealous in the discharge of their duties. Very beneficial results have followed the introduction of this system, and it is to be strongly commended to all Superintendents. The wooden batea and miner's gold pan are used for panning out.

The average value of the ore worked is the value of the gold saved, plus the value of the sulphurets saved, plus the value of the tailings lost. From these factors is calculated the percentage of gold saved by the mill. This represents the efficiency of the process. Other things being equal

this will vary with the character of the ore. Where the gold is very fine and where the sulphurets are of a brittle character the percentage saved will be less than in the treatment of more favorable ores. Most of the loss occurs in the loss of sulphurets, consequently ores carrying a large percentage of rich sulphurets may have comparatively rich tailings. There are few ores in mines in operation in this State from which 80 per cent and upwards of the assay value can not be extracted by skilled millmen with good mills. The majority of mills save at least 75 to 85 per cent of the assay value of the ores. Careful investigation at the North Star and Empire Mills, carried on for one and a half years, show a saving of from 82 to 94 per cent of the assay value deduced as explained above. The usual percentage saved, according to reliable semi-monthly reports from these mills, is from 86 to 90 per cent of the assay value of the ores. In these estimates, of course, no deduction is made for the loss of gold in the subsequent treatment of the sulphurets, usually unimportant in this connection.

Mill Labor per Twenty-four Hours.

One man at rock breaker, at $2 50	$2 50
Two amalgamators, at $3	6 00
Three concentrators; one at $3, and two at $2 50	8 00
Total	$16 50

The rock breaker man also attends to the blanket sluices, and is employed in other tasks about the mill. Where steam power is employed in addition to the above force, two engineers and one man to pile the wood near the boilers, etc., are required.

Cost of milling per ton in forty-stamp gold mill (water power), capacity eighty tons per twenty-four hours:

Labor—			
Mill labor			$0 20½
Assaying, retorting, and superintendence			02½
Total			$0 23
Supplies—			
Castings	$0 07	to	$0 10
Quicksilver	01½	to	04
Lubricants, screens, illuminants, machinists' time, incidentals	04	to	08
Total	$0 35½	to	$0 45

To this must be added the cost of water power, which is very variable.

Where steam power is used the above estimate should be increased about 10 cents per ton for labor. Repairs, lubricants, etc., incident to the use of steam power plant, increase the cost about 1 cent per ton. An electric plant to illuminate the mill, the office, etc., costs about $600. The cost of producing the light is but little beyond the cost of power to run the dynamo. Good illumination is very desirable about a mill.

The charge for assaying, retorting, and superintendence is based upon the salary of $120 per month for a man to perform these duties, in addition to rendering other services, *i. e.*, clerk, timekeeper, etc., about the mine. One half of his time is charged to the cost of milling, while the other half is charged to the cost of mining. At some works the Superintendent of the mine performs these duties.

Power for Forty-stamp Gold Mill.

1 rock breaker	12	horse power.
40 stamps	66	horse power.
16 concentrators	8	horse power.
8 shaking tables	2½	horse power.
1 clean-up pan	1½	horse power.
1 revolving barrel and batea	2	horse power.
Total	92	horse power.

The revolving barrel, batea, and clean-up pan may be run while the rock breaker is stopped, thus saving three and one half-horse power. About ninety-horse power will be required for a forty-stamp mill.

Where the cost admits of its use, water power is preferable to steam power.

The use of water for power effects a saving in—

First—The cost of a steam plant.

Second—The cost of labor (see mill labor).

Third—The cost of fuel. The cost of fuel is from $3 to $5 per cord in California. It takes from one fifteenth to one eighth cord of wood per ton of ore crushed.

Fourth—The cost of repair of engines, boilers, lubricants, etc.

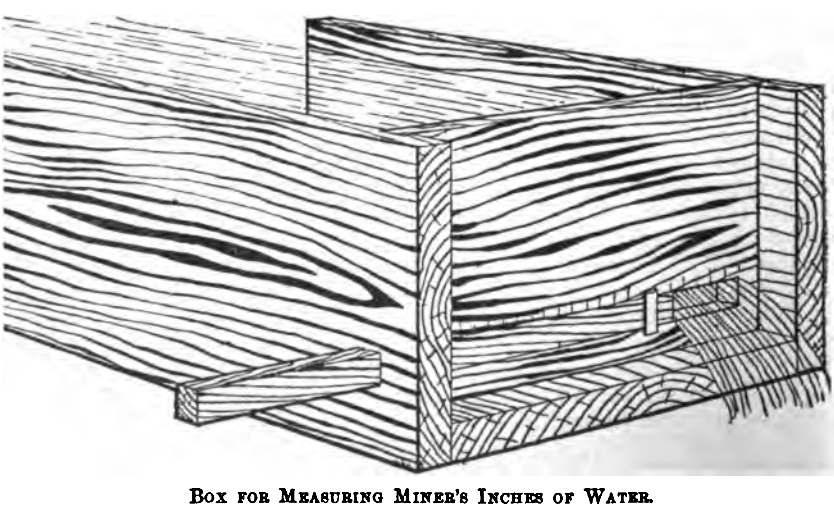
Fifth—It decreases the liability of fire, and affords at the same time means of extinguishing fires.

Sixth—The power is more constant than steam power.

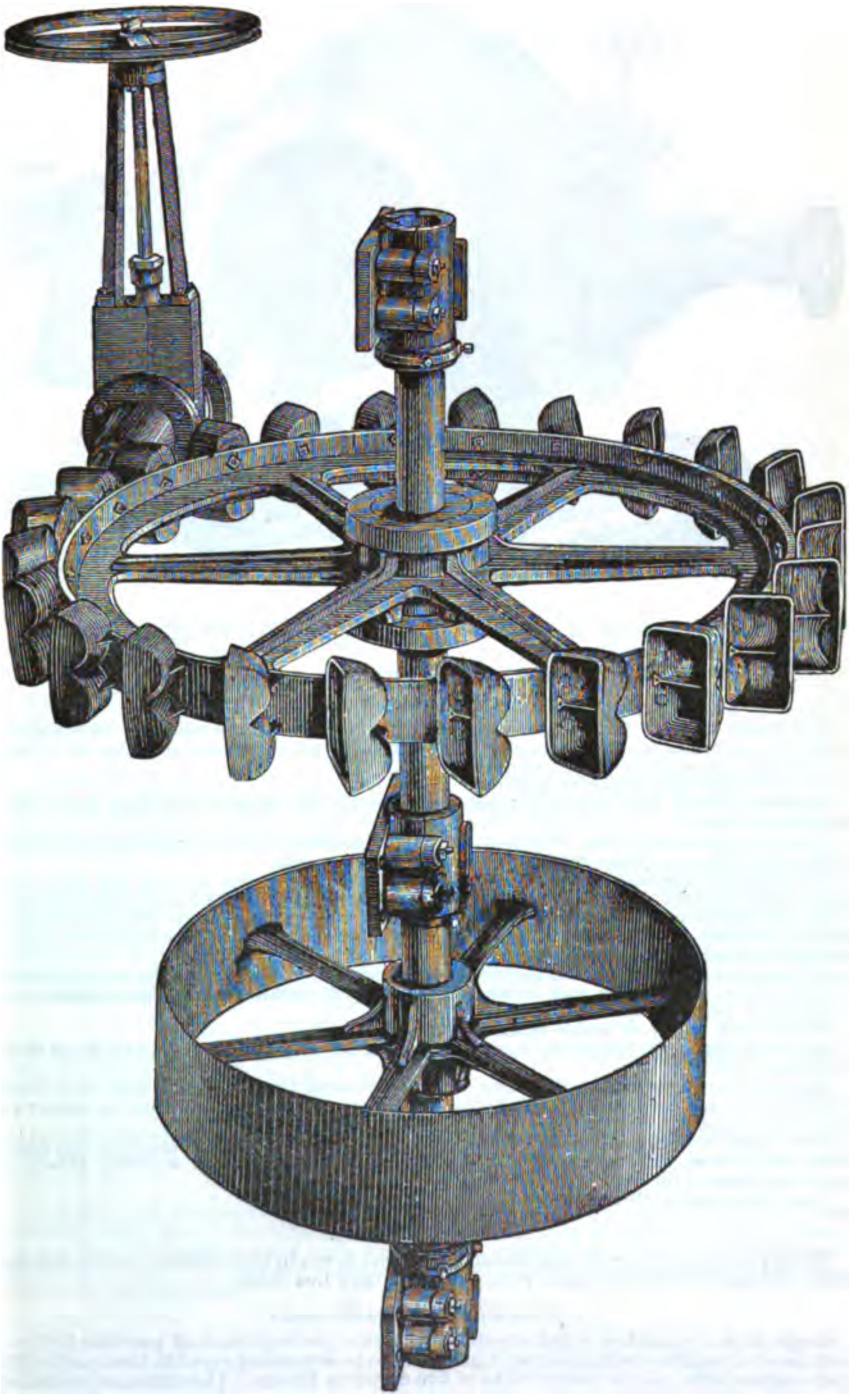
When water power is used in California the power is developed, where sufficient pressure is attainable, by improved hurdy-gurdy wheels.

These wheels revolve vertically. They have "buckets" of various designs, set radially upon the periphery of the wheel. The water is projected through a nozzle against these buckets and generates the power. Where water under high pressure cannot be obtained, Leffel's turbines, or overshot water wheels, are used.

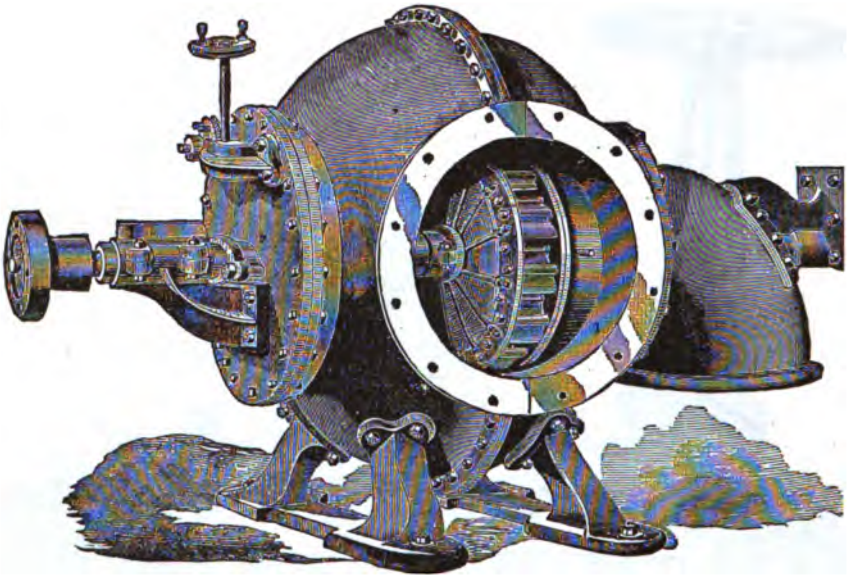
Of the class of hurdy-gurdy wheels the Pelton and the Knight wheels are most commonly used. The power developed by the Pelton may be placed at about 75 to 80 per cent of the theoretical power of the water. Under more favorable conditions this wheel is capable of developing several per cent higher efficiency than the above figures.



BOX FOR MEASURING MINER'S INCHES OF WATER.



THE PELTON WATER WHEEL.



LEFFEL TURBINE.

SPECIFICATIONS OF A FORTY-STAMP GOLD MILL (WATER POWER).

MACHINERY.

Water Wheels and Pulleys.

One water wheel, 6 feet in diameter, to drive the battery; the wheel to be supplied with a shaft, boxes, collars, gate, and nozzle, automatic governor, and a pulley 36 inches in diameter, grooved for 1½-inch manilla ropes.

One driving pulley, 12 feet in diameter.

One idler pulley, 48 inches in diameter, grooved for one 1½-inch rope, and fitted with shaft and boxes.

One slack tightener pulley, 48 inches in diameter, grooved for one 1½-inch rope, and fitted with shaft, boxes, carriage, track, and counterbalance weight.

The rope for transmission is to be put on in one piece, passing around the idler and slack tightener (which are to be set on an angle in such a way that they will take the rope from one side of one of the main pulleys and pass it on to the opposite side of the other pulley), thereby making but one splice in the whole rope, which will be kept in constant tension by the slack tightener.

One wheel, 4 feet in diameter, to drive the rock breakers; the wheel to be supplied with a shaft, boxes, collars, gate, and nozzle, and a pulley 34 inches in diameter, grooved for one 1½-inch manilla rope.

One driving pulley, 60 inches in diameter.

One idler pulley, 30 inches in diameter, grooved for one 1½-inch rope, and fitted with shaft and boxes.

One slack tightener pulley, 30 inches diameter, grooved for one 1½-inch rope, and fitted with shaft, boxes, carriage, track, and counterbalance weight; rope to be put on similar to that for the battery.

One wheel, 36 inches diameter, to drive the concentrators; the wheel to be supplied with shaft, boxes, collars, gate, and nozzle, automatic governor, and a pulley 16 inches diameter grooved for one 1-inch manilla rope.

One driving pulley, 48 inches diameter.

Forty-Stamp Battery.

Stamps to weigh 850 to 900 pounds each, arranged to run in eight batteries of five stamps each, by belts and friction clutch pulleys from battery line shaft.

Eight High Cast-Iron Mortars.

Single discharge, each to weigh about 5,000 pounds; to be planed all over the bottom, and faced where the apron joins on; eight holes to be accurately cored in the base for 1½-inch anchor bolts. Each mortar to have five cast-iron linings. The aggregate weight of these linings is about 500 pounds per mortar.

Eight Cast-Iron Aprons.

To be faced where they join on to the mortars, and fastened in place with ⅝-inch bolts.

Eight Sugar Pine Screen Frames.

To have iron facings put on the ends where the keys bear against them; the edges to be fitted with dowel pins to join them to the inside plate block.

Sixteen Inside Plate Blocks.

Two sets, one to be 6 inches high, and the other to be 4 inches high; to be well fitted into the mortars, and to have plates fitted and fastened on with brass screws; blocks to be bolted together to keep them from splitting, and to be fitted with iron facings where the keys bear against them, and well fitted to the screw frames.

Eight Brass Wire Screens.

No. 30 mesh, to be fastened on to the screw frames with copper tacks.

Sixteen Gilt-headed End Keys.

For screen frames, to be well fitted in place.

Sixteen Bottom Keys.

For screen frames, to be well fitted in place.

Sixty-four Foundation Bolts.

For mortars, to be 1¼-inch diameter by 36 inches long, with hexagon nuts on the top ends and steel keys in the bottom ends.

Sixty-four Wrought-Iron Washers.

Four inches by 4 inches by ¾ inch, for bottom ends of foundation bolts.

Eight Sheets of Rubber.

One quarter inch thick by 30 inches by 60 inches, for mortar foundation. Mill blankets tarred may be used in place of rubber.

Forty Chrome Steel or Cast-Iron Dies.

Nine inches diameter by 7 inches high, with square base well fitted into the mortars, 10 inches from center to center.

Forty Chrome Steel Shoes.

Nine inches diameter by 8 inches high, with tapered shank 3¾ inches diameter at top end, by 4¾ inches diameter at bottom end by 5 inches long, to fit into the stamp heads by being covered with dry, hard pine ⅜ inch thick; this being driven in by being allowed to drop a few times on to the bare die.

Forty Chrome Steel Stamp Heads.

Nine inches diameter by 17 inches long, with a conical socket cored into the lower end, 4 inches diameter at inner end and 5⅛ inches diameter at the outer end, and 5½ inches deep, and a conical socket cored and accurately bored out to fit the tapered end of the stamp stem 2⅞ inches diameter at inner end, and 3¼ inches gauge at the outer end by 6 inches deep. Transverse rectangular keyways are to be cored through the stem head 1 inch by 2½ inches for loosening the shoes and stems.

Two Steel Loosening Keys.

Seven eighths of an inch thick by 1 inch at the point (2 inches at the head) by 18 inches long, for loosening the shoes and stems.

Forty Best Refined Iron or Mild Steel Stems.

Turned perfectly true, full length, 3¼-inch gauge by 14 feet long, to be tapered on both ends to accurately fit the stamp heads. Each stem weighs about 360 pounds.

Forty Chrome Steel, Double-Faced Tappets.

Nine inches in diameter by 11 inches long, with a steel gib and two steel keys accurately fitted in place. Both faces to be turned true. Tappets to be bored with the gibs in place to accurately fit the stems, and to be counterbored opposite the gibs by moving the center ¼ inch away and, with diameter ⅛ inch less than the bore, taking a cut ⅛ inch deep. Each tappet weighs 112 pounds.

Eight Upper and Eight Lower Guides.

With cast-iron frames. Guide blocks to be made of good, dry maple timber and well fitted in place. The guides may also be made entirely of wood. See cuts.

Four Extra Quality Mild Steel Cam Shafts.

Turned true full length $5\frac{1}{2}$-inch gauge diameter by 14 feet long; key-seated for cams and pulley; key-seats must not run through the bearings.

Ten Heavy Corner Boxes.

Five and one half-inch gauge bore; 8 of them to be 12 inches long, and 2 to be 20 inches long. All of them to be planed all over the bottoms and backs, and furnished with bolts 1 inch diameter, to fasten them to the battery frame.

Forty Double Armed Chrome Steel Cams.

Twenty right and 20 left hand, to be made 29 inches long over all, the hub to be 11 inches diameter and $5\frac{1}{2}$ inches through the bore; the lifting faces to be $2\frac{1}{2}$ inches wide, and ground smooth; the hubs to be bored to fit the shaft accurately, and properly key-seated and fitted with steel keys, and each marked to their respective places, giving them a combination as follows: Counting from the left hand side, when facing the battery, throughout the full ten stamps of each cam shaft, No. 1 cam will drop its stamp first; then Nos. 8, 4, 10, 2, 7, 5, 9, 3, and 6 consecutively. This is the order: 1, 4, 2, 5, 3. Each cam weighs about 158 pounds. The curve of the face of the cam is the involute of a circle, usually slightly modified.

Four Pairs of Cast-Iron Double Sleeve Flanges.

For wood pulleys; flanges to be 36 inches diameter, and 14 inches through the bore; to be turned all over the inside, where they fit on the wood. The outside flange is to be bored and fitted to the sleeve and fastened with a gib-headed steel key. The hub to be bored and fitted to the cam shaft and fastened with a steel key.

Four Wood Pulleys.

Seventy-two inches diameter by 17 inches face; to be made of best kiln-dried sugar pine, and all joints to be filled with white lead in oil. The cast-iron flanges to be well fitted on and bolted with 12 $\frac{7}{8}$-inch bolts.

Eight Wrought-Iron Collars.

For cam shafts, $5\frac{1}{2}$-inch bore, fitted with 2 steel set screws in each.

Eight Wrought-Iron Jack Shafts.

Three inches diameter by 60 inches long; black finish.

Sixteen Cast-Iron Jack Shaft Side Brackets.

With 4 lag screws $\frac{5}{8}$ inch by 6 inches for each, to fasten them in place.

Forty Open Latch Sockets.

Lined with leather.

Forty Wood Finger-bars.

To be fitted and bolted to the above sockets and furnished with wrought-iron caps and handles.

A Complete Set of Water Pipes.

For a battery of 40 stamps, with all fittings, cocks, and connections.

Bolts and Washers for Battery Frame.

Six brace rods, $1\frac{1}{4}$ inches by 25 feet, 7 inches between two nuts.
Six brace rods, $1\frac{1}{4}$ inches by 12 feet, 6 inches between two nuts.
Twenty-six bolts for mudsills, 1 inch by 30 inches.
Twenty-four bolts for yokes, 1 inch by 28 inches.
Twenty-four bolts for yokes, 1 inch by 52 inches.
Forty-eight bolts for guide girts, 1 inch by 32 inches.
Four bolts for knee beam, 1 inch by 28 inches.
Thirty-six splice bolts for mudsills, $\frac{7}{8}$ inch by 16 inches between head and nut.
Twelve splice bolts for tail girt, $\frac{5}{8}$ inch by $9\frac{1}{2}$ inches between head and nut.
Thirty-two bolts for mortar blocks, 1 inch by 59 inches from point to point.
Sixty-four bolts for mortar blocks, 1 inch by 65 inches from point to point.
Twenty-four joint bolts for posts, 1 inch by 35 inches between two nuts.
Six joint bolts for knee posts, 1 inch by 45 inches between two nuts.
Six joint bolts for knee posts, 1 inch by 35 inches between two nuts.
Twenty-four joint bolts for knee beams, 1 inch by 43 inches between two nuts.
Ten joint bolts for tail girts, 1 inch by 21 inches between two nuts.
Twenty-four cast-iron washers for $1\frac{1}{4}$-inch rods.
Five hundred and fourteen cast-iron washers for 1-inch bolts.
Seventy-two cast-iron washers for $\frac{7}{8}$-inch bolts.
Twenty-four cast-iron washers for $\frac{5}{8}$-inch bolts.
Forty sheet-iron washers $3\frac{1}{2}$ inches square by $\frac{1}{4}$ inch thick for 1-inch joint bolts.

Battery Line Shafting and Pulleys.

One shaft 5½-inch gauge by 18 feet long, properly key-seated.
One shaft 5-inch gauge by 15 feet 6 inches long, properly key-seated.
One shaft 5-inch gauge by 17 feet, properly key-seated.
One shaft 4-inch gauge by 17 feet long, properly key-seated.
Two shafts 3-inch gauge by 10 feet 6 inches long, properly key-seated.
Two face couplings 5-inch gauge, properly fitted and keyed in place.
One face coupling 4-inch gauge, properly fitted and keyed in place.
Two face couplings 3-inch gauge, properly fitted and keyed in place.
Two babbitted boxes 5½-inch gauge.
Three babbitted boxes 5-inch gauge.
Two babbitted boxes 4-inch gauge.
Two babbitted boxes 3-inch gauge.

All of the above boxes to be made of the same height, planed all over the bottoms, with drip cups cast on to the sides, and furnished with suitable bolts to fasten them to the 16-inch battery knee beams.

Two collars for 5½-inch shafting, with two steel set screws in each.

Four friction clutch pulleys, 48 inches in diameter, and 16½-inch face, complete, with levers and connections. Pulleys to be fitted to line shaft in their proper places, with phosphor-bronze bushings; the drivers to be properly keyed on with steel keys.

One pulley 6 feet in diameter, grooved for three 1½-inch manilla ropes; pulley to be well balanced and keyed to the shaft with a steel key.

Water Pipes.

Sufficient 3-inch pipes and fittings to connect battery pipes with the feed water tanks.

Traveling Hoist.

One traveling crawl, with track, iron, and nails, to extend full length of battery.
One 2-ton Weston's differential chain block. See cut.

Ore Feeders.

Eight Challenge self-feeders, complete, for batteries, with all connections.

Ore Bin Gates.

Eight ore bin gates, 18 inches by 24 inches, for fine ore, with guides, racks, pinions, shafts, boxes, hand wheels, and bolts.

Three ore bin gates, 24 inches by 36 inches, for coarse ore, with guides, racks, pinions, shafts, boxes, hand wheels, and bolts.

Sluices and Aprons.

Eight cast-iron aprons, 54 inches wide by 56 inches long, to be fitted under the lip of the mortar apron.

Eight silver-plated copper plates, 54 inches by 56 inches by ⅛ inch, to be made of best Lake Superior copper, and to have one ounce of silver per square foot; plates to be fitted into the cast-iron aprons, and fastened by strips of wood on the sides, which are bolted to the sides of the apron.

Eight cast-iron sluices, 54 inches wide by 12 feet long, to be made into two sections and bolted together by flanges, the lower section to have a quicksilver trap or trough cast on to the end, extending the full width of the sluice, and to have a connection made for a 2-inch pipe to conduct the pulp to the dividing tanks, and thence to the concentrators.

Twenty-four silver-plated copper plates, 54 inches by 48 inches by ⅛ inch, to be made of best Lake Superior copper, and to have one ounce of silver per square foot; plates to be fitted into the sluices, overlapping at the joints, and to be fastened in place in the same manner as those in the apron.

There are to be eight silver-plated copper shaking tables, one for each battery, placed below the apron plates. These tables consist of a light iron framework suspended upon movable springs. This table is given a longitudinal oscillation by means of eccentrics.

Dividing Tanks and Pulp Pipes.

Eigh cast-iron dividing tanks, 10 inches long by 8 inches wide by 6 inches deep, with 2-inch pipe connection in one end and two 1½-inch pipe connections in the other end, each to have a wooden swinging tongue put in so as to direct the pulp to either of the 1½-inch pipes, or a part to the one and a part to the other. The tanks are to be connected with the sluices by 2-inch pipes, and with the concentrators by 1½-inch pipes.

Inside Plates and Blocks.

Three wooden blocks for each mortar, to be 3 inches, 4½ inches, and 6 inches high, respectively, to be fitted into the mortars under the screw frames; each block to have iron facings, fitted in flush and screwed on where the keys come, and to have a silver-plated copper plate bent to the proper shape and screwed on with silver-plated brass screws; the copper plates to be made of best Lake Superior copper, 6 inches by 50 inches by 3/16 inch, and to have one ounce of silver per square foot.

Concentrators and Shafting.

Sixteen endless belt concentrators, complete, with water pipes and fittings to connect with supply tanks. All sulphuret tanks complete, to be made of good redwood lumber.

One piece of shafting, 2¼ inches by 16 feet.

Six pieces of shafting, 2 inches by 16 feet.

Three pieces of shafting, 2 inches by 10 inches.

Eight face couplings, 2 inches.

Four babbitted boxes, 2¼ inches, with bolts for 8-inch timber.

Eighteen babbitted boxes, 2 inches, with bolts for 8-inch timber.

Two collars, 2¼ inches, with steel set screws.

Two collars, 2 inches, with steel set screws.

One pulley, 48 inches in diameter, grooved for one 1 inch in diameter rope, and properly fitted and keyed with a steel key to the 2¼-inch shaft.

Two pulleys, 6-inch face by 36 inches diameter, properly fitted and keyed with steel keys to the 2-inch shaft.

Sixteen pulleys, 4-inch face and 10 inches diameter, properly fitted and keyed with steel keys to the 2-inch shaft.

Sixteen loose pulleys, 4-inch face by 10 inches diameter, properly fitted to the 2-inch shaft.

Sixteen collars with steel set screws for same.

Rock Breakers and Shafting.

Two rock breakers, 9 inches by 15 inches.

One piece shafting, 4 inches by 16 feet.

One piece shafting, 3½ inches by 16 feet.

One piece shafting, 3 inches by 16 feet.

One face coupling, 3½ inches.

One face coupling, 3 inches.

Three babbitted boxes, 4 inches, with bolts for 10-inch timber.

Two babbitted boxes, 3½ inches, with bolts for 10-inch timber.

Two babbitted boxes, 3 inches, with bolts for 10-inch timber.

Two collars, 4 inches, with steel set screws.

One pulley, 48 inches diameter, grooved for 1 and 1¼-inch manilla rope, and properly fitted and keyed to the 4-inch shaft, with a steel key.

Three pulleys, 20 inches straight face by 20 inches diameter, properly fitted and keyed to the shafting.

Clean-up Barrel.

One clean-up barrel, 24 inches inside diameter by 48 inches inside length, to be made of cast-iron 1¼ inches thick, with two discharge openings 5½ inches diameter in the sides diametrically opposite each other, the heads and discharge doors to be accurately fitted; journals to be 4-inch gauge, cast on to the heads; 1 tight and one loose pulley 7-inch face by 30 inches diameter.

Two babbitted boxes, 4-inch gauge.

One driving pulley, 6 inches diameter by 14-inch face.

Batea.

One batea 48 inches diameter, with gears and hangers complete, and tight and loose pulleys 4½-inch face by 16 inches diameter.

One driving pulley, 9-inch face by 21 inches diameter.

Machinery for Clean-up Room.

One clean-up pan, 24 inches inside diameter, with tight and loose pulleys.

One driving pulley, 8-inch face by 16 inches diameter.

One cast-iron washing tank, 24 inches by 30 inches by 24 inches deep, with three pipe connections for drawing off water.

One cast-iron washing tank, 30 inches by 36 inches by 24 inches deep, with three pipe connections for drawing off water.

One cast-iron washing tank, 30 inches by 54 inches by 30 inches deep, with three pipe connections for drawing off water.

One marble top, complete for washing tanks.

One side washstand, with pipes and fittings.

All pipes and fittings necessary to bring water to the clean-up pan and washing tanks.

Retort and Melting Furnace.

One retort, 10 inches by 36 inches, inside dimensions, with amalgam trays, condenser, catch tank, furnace front, bearers, bars, smokestack, and base plate, gay rods, dampers, binders, and all pipes and fittings to bring water to the condenser.

One cast-iron melting furnace, complete, with doors, grate bars, bearers, cast-iron shell, and damper.

Two bullion molds for 500 and 750 ounces.

Four black lead crucibles, No. 16, with covers.

One crucible tongs for No. 16 crucible.

One skimmer for bullion.

KNIGHT WHEEL.

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eams are
smaller than the timbers they frame into, they must be housed in ½ inch deep, *i. e.*, the timber must not be boxed out clear across.

The cam shaft is to be set $4\frac{3}{4}$ inches from the center to the center of the stems.

A 2-inch plank floor is to be put on top of the knee beams, which is to be planed on the under side; also, a 2-inch double board floor to be put in back of the battery, on about the same level as the knee beams.

The whole battery frame to be painted with two coats of light-cream paint, properly mixed with oil, and the wood pulleys and guides to be painted blue, the iron work to be painted black. The out-board bearing frame to be made of 12-inch by 16-inch timber, planed all over, well framed and bolted together, and anchored to a solid stone foundation, as shown in plan, and to be painted same as battery frame.

Transmission Ropes and Belts.

Six hundred feet best manilla or cotton rope, 1½ inches in diameter, to drive battery line shaft.

Two hundred and fifty feet best manilla rope, 1½ inches in diameter, to drive rock-breaker line shaft.

One hundred and fifty feet best manilla rope, 1 inch in diameter, to drive concentrator line shaft.

Two hundred feet best rubber belting, 16 inches by 5-ply, for batteries.

One hundred and eighty feet best rubber belting, 10 inches by 4-ply, for rock breakers.

Thirty-two feet best rubber belting, 7 inches by 4-ply, for clean-up barrel.

Sixty-five feet best rubber belting, 6 inches by 4-ply, for batea.

Thirty feet best rubber belting, 6 inches by 4-ply, for concentrator shafting.

Four hundred and twenty feet best rubber belting, 3 inches by 4-ply, for concentrators.

Thirty feet best rubber belting, 3 inches by 4-ply, for clean-up pan.

BUILDINGS, AND ERECTION OF MILL, ETC.

Stonework.

All foundations and retaining walls to be built of large stone, properly banded, and well laid in cement mortar, composed of ten parts good, clear sand, two parts good quality of lime, and one part best Portland cement, special care being taken to keep all dirt or clayey material excluded; all exposed faces of retaining walls to be well pointed up and finished with the same material.

Ore Bins.

Mudsills to be made of 12-inch by 14-inch timbers, laid flatwise.

Foundation posts to be made of 14-inch by 14-inch timbers.

Sills, posts, and caps for ore bins proper to be made of 12-inch by 12-inch timbers; the posts to be boxed into the sills and caps 1 inch.

Braces for incline bottom, to be made of 10-inch by 12-inch timbers.

Supporting braces to be made of 8-inch by 12-inch timbers.

All planking to be 3 inches thick and lined throughout with 1 inch boards to break joints over the planks.

Battery Frame.

Mudsills to be made of 14-inch by 16-inch sugar pine, or good yellow pine free from sap; to be well bedded in concrete, which must be put on to the clean bedrock. Linesills to be made of 12-inch by 16-inch and 20-inch by 16-inch sugar pine or yellow pine, of good quality, to be well bolted down to the mudsills.

Mortar blocks to be made of two pieces each, to be 30 inches thick and wide enough to fill space between the linesills and battery posts. All to be sized and well fitted.

The timbers for mortar blocks are to be accurately fitted together and secured with six 1-inch bolts, and two oak keys, 4 inches wide by 5 inches thick at the point and 6 inches at the head. Keys to be accurately fitted and firmly driven. Blocks to be sized and finished above the floors.

Yokes to be made of 10-inch by 10-inch timber, well fitted and bolted to the linesills and battery posts.

Battery posts to be made of 12-inch by 24-inch and 20-inch by 24-inch, good quality pine timber, to be dressed all over, and bolted down to the linesills with 1-inch joint bolts, the large posts to be made with double tennon on the bottom. The knee beams to be made of 12-inch by 16-inch timber, dressed all over. The knee posts to be made of 12-inch by 16-inch timber, dressed all over. The stringer on top of knee posts to be made of 12-inch by 16-inch timber in two pieces, to be spliced with a ship splice 3 feet long, stringer to be dressed all over. Knee posts to be framed into stringer with double tennons; outside stringer at end of knee beams to be made of 8-inch by 12-inch timber in two pieces, spliced with ship splices in center 3 feet long, and to be dressed all over.

Bottom guide girt to be made of 12-inch by 16-inch timber, dressed all over, one piece for each 20-stamp battery, and to extend past the outside posts 12 inches; the top girt to be made of 12-inch by 14-inch timber, dressed all over, and made the same length as the lower ones; all braces to be made of 8-inch by 12-inch timber, dressed all over, and framed with double tennons; no keys are to be used in braces or guide girts, but they must be accurately fitted without.

All boxing about battery frame to be ½ inch deep, and where braces or knee beams are smaller than the timbers they frame into, they must be housed in ½ inch deep, *i. e.*, the timber must not be boxed out clear across.

The cam shaft is to be set 4¾ inches from the center to the center of the stems.

A 2-inch plank floor is to be put on top of the knee beams, which is to be planed on the under side; also, a 2-inch double board floor to be put in back of the battery, on about the same level as the knee beams.

The whole battery frame to be painted with two coats of light-cream paint, properly mixed with oil, and the wood pulleys and guides to be painted blue, the iron work to be painted black. The out-board bearing frame to be made of 12-inch by 16-inch timber, planed all over, well framed and bolted together, and anchored to a solid stone foundation, as shown in plan, and to be painted same as battery frame.

Water Wheel Frames

Are to be made of 12 by 12 lumber throughout, well anchored down to a stone foundation. That part of the frame which comes above the floor is to be dressed and painted the same as the battery frame.

The water wheels are to be housed with tongued and grooved lumber, 4 inches wide.

BUILDINGS.

Frame Work.

Ore house main frame is to be made of 8 by 8-inch timbers throughout, with 3-inch by 6-inch girts and studding.

Battery and concentrator rooms frame is to be made of 8-inch by 10-inch posts and chords, 6-inch by 10-inch sills, 8-inch by 8-inch principal rafters and straining beams, 4-inch by 8-inch truss braces, and 3-inch by 6-inch girts and studding.

Clean-up, sulphuret, and water wheel rooms main frames are to be made of 8-inch by 8-inch timbers, with 3-inch by 6-inch girts and studding.

Floors.

Ore house floors to be made of one thickness of 2-inch planks.

Battery, concentrator, and water wheel rooms floors are to be made of 1-inch by 8-inch lumber, double thickness, surfaced on top, to be supported on 3-inch by 6-inch joists 18 inches apart.

Sulphuret and clean-up rooms floors are to be made of concrete laid on top of a heavy wood floor, which is to be supported on foundations made of 8-inch by 8-inch timbers.

Roofs.

All roofs are to be made with 2-inch by 8-inch rafters 18 inches apart, with 1-inch by 6-inch boards 4 inches apart, and covered with No. 26 standing seam painted iron roofing.

Walls.

All walls are to be covered with 1-inch by 10-inch rustic.

Cornices.

All cornices are to project 24 inches, measured horizontally from the walls of building, with a 12-inch frieze and a 5-inch facia made of dressed lumber.

Windows.

All windows, except those for sulphuret room, are to be made of 12 lights of 10-inch by 16-inch glass, and frames made to suit of dressed lumber, with casing outside 5 inches wide.

Twelve windows are to be put into the ore house.
Seven windows are to be put into the battery room.
Six windows are to be put into the clean-up room.
Twelve windows are to be put into the sulphuret room.
Five windows are to be put into the water wheel room.

Skylights.

Six skylights, made of 12 lights of 10-inch by 20-inch glass, to be put into the roof of the concentrator room.

Doors.

All doors, both sliding and swinging, to be 3 feet by 7 feet by 1¾ inches thick with pannels.

Two sliding doors to be put into the ore house.
One outside swinging door to be put into the battery room.
One swinging door leading from the battery room to the clean-up room.
Two sliding doors leading from the concentrator room to the sulphuret room.
Two outside sliding doors for the sulphuret room.
One outside swinging door for the water wheel room.

All doors to be set in good, substantial casings, outside cased with surfaced lumber, and furnished with all trimmings and locks.

Stairs.

There is to be a flight of stairs at each end of the mill, one flight leading from the battery room floor to the floors above, and one flight of stairs from the battery room floor to the concentrator room floor.

All stair stringers to be made of 2-inch by 12-inch lumber, and treads of 2-inch by 10-inch lumber.

Hand Rails

Are to be put on to the outside of all stairs and around the landing of same, also in front of the battery room floor and all other floors and platforms where there is danger of falling. All to be made of dressed lumber well painted.

Retort House and Assay Office,

To be 20 feet wide by 48 feet long, with a retort and melting furnace room, a weighing room, and a storeroom; the two latter to be lath and plaster finished, and the whole building to be finished similar to the mill buildings, with iron roof, rustic, etc.

Paint and Whitewash.

All buildings are to be painted on the outside with a good coat of brown mineral paint, and the window and door casings and cornices to be painted with two coats of white lead paint.

The mill to be whitewashed throughout the inside, including the building frame, ore bins, etc.

Tanks.

There are to be two 4,000-gallon redwood tanks, 3-inch stock, set up at the end of the mill upon strong timber foundations, and one tank 8 feet wide by 10 feet long by 4 feet high, inside measurement, to be made of 3-inch planks with 8-inch by 8-inch frame; planking to be well fitted together and properly caulked inside with oakum. This tank is to be set at the end of the last sluice box coming out of the mill.

Drain Boxes and Tailings Sluices.

Battery sluices and aprons to be set on framework so arranged that the grade can be changed easily. This framework to be planed all over. Sluices and frames to be painted same as battery frame.

There will be a sluice in front of battery room floor, made of surfaced lumber; also to be painted and so arranged as to conduct any water away which drips from the floor.

There will be sluices put in under the concentrator room floor, two of which will be 6 inches wide by 8 inches deep, to run lengthwise to catch the tailings from the concentrators, and one to be 8 inches wide by 10 inches deep to run crosswise and to take the tailings from the first two sluices and conduct the same outside. All tailings sluices to have a fall of one in twelve, and to be made of 2-inch lumber, well fitted and nailed together. Proper sluices from the clean-up room, to conduct water and tailings therefrom, must be connected to tailings sluices under concentrator room.

All sulphuret boxes and drain boxes for concentrators to be made of good quality of redwood lumber, 1¼ inches thick, dressed on both sides and well fitted and screwed together.

The cost of this mill exclusive of building, $32,000. The weight of all parts, two hundred and forty thousand pounds. There are three hundred and twenty-five thousand feet of lumber in the building. Lumber costs about $18 per thousand in most of the mining districts.

DRIFT MINING IN CALIFORNIA.

By Russell L. Dunn, E.M., Assistant in the Field.

Drift mining is peculiarly a California development of the gold placer mining industry, originating from the exceptional conditions of location of the larger area of these auriferous deposits. The placers by geological age and local condition are generally divisible into two classes. First, the so called blue-lead or ancient river channel placers, the result of river wash and erosion of the pliocene or quarternary age, or of both, geological authorities differing. Second, the recent deposits of existing streams. The latter, though covering a wider range of country than the older placers, are comparatively limited in aggregate area, being for the most part the river and stream beds and their banks and bars. Being accessible and workable by primitive methods without the need usually of any capital, except that of labor itself, they were readily discovered and rapidly worked out. The gold they contained came very largely from the blue-lead ancient river channels that were cut through and eroded away by the present river system. A small portion only seems to have come from the direct disintegration by these streams of the auriferous slates, talcose rocks, and quartz lodes. Though some of the deep bars and portions of their channels that have been covered by slides are worked by the methods and appliances of drift mining, it is with the remains of the ancient river channels that the industry is most closely connected.

Geographically, the ancient river system, whose buried channels are so auriferous, extended from what is now Butte and Plumas Counties on the north to Tuolumne on the south, and from the eastern edge of the Sacramento Valley almost to the summit of the Sierras. Within these limits are included portions of the Counties of Butte, Sierra, Plumas, Yuba, Nevada, Placer, El Dorado, Amador, Calaveras, Tuolumne, and Stanislaus, in all (roughly approximated) an area of 7,000 square miles, only a small portion of it, however, being actually covered by the remains of the ancient channels. The topography of this section has been formed by tributaries of the Sacramento rising at the summit of the Sierras and flowing in the precipitous cañons of their erosion, till the Sacramento Valley is reached. Starting at the valley, the beds of these cañons rise from ten to forty feet to the mile for the first forty or fifty miles, thence with much steeper grades to the river headwaters, only a thousand or so feet below the summit of the Sierras. The narrow ridges between the cañons rise from the plains with mean grades of from one hundred to one hundred and fifty feet to the mile, to summit elevations of from six thousand to eight thousand feet. The topography of the country during the existence of the pliocene and quarternary rivers cannot now be restored with more than probable certainty. It seems likely that the river system then was very similar to the present one in relative location and direction of flow of the main streams, at least particularly through the northern portion of the district. At Oroville, in Butte County, is the debouchure of a great river coming from the north and corresponding to the present Feather River, and apparently draining much the same territory. At Smartsville, in Yuba County, is the evidence of an ancient river the counterpart of the

present Yuba. The main stream can be traced up the "Ridge," as it is locally known, lying between the Middle and South Forks of the Yuba to about Moore's Flat, thence northward into Sierra County. Remains of what must have been its tributaries are observable all over northern Nevada County and central and northern Sierra into Plumas County. In Placer County, from Auburn southwesterly, there are the remains of an old river channel, the predecessor of the present American. Higher up in the mountains there is a tangled network of old channel fragments that were once part of its system. Further south at La Grande, in Stanislaus County, is the outlet for the pliocene rivers of Tuolumne and probably Calaveras and Amador Counties. A careful study and comparison of the location, direction, elevation, and grade of the remains of the channels is convincing that there is not one main great blue-lead channel coming from north to south, as supposed for many years after the mines in them were discovered and worked, with tributary channels coming in from the east and the west, a system analagous to the main Sacramento, but in the mountains fifty miles east of it, but that, as already stated, the system was much the same as at the present time. In the northern portion of the district the channels can be traced for long distances, have indeed been somewhat restored by mining operations in them, and their continuity and identity established with considerable certainty. In the southern portion the remains of the old channels are very fragmentary, either as a result of more complete subsequent erosion, or because the system originally was not as extensive or permanent. A complication of the problem of identity of the more or less isolated fragments of these channels comes from indisputable evidence that there were two, and in some localities more, systems formed necessarily in different periods of time.

The ancient streams, as indicated from the immense masses of drift gravels and detritus they have left in their channels, probably carried much larger volumes of water than the present streams. The mean gradient of their beds was considerably more than that of the existing streams at corresponding points, for although in the enormous lapse of time great local changes in elevation are possible, it is almost certain that the elevation of the Sierra Nevada mountain chain to substantially its present condition and altitude was in the later cretaceous or early tertiary periods. The changes in it have been the result of glacial and stream erosion and of lava flows not, as far as the section under consideration is concerned, of local genesis. The periods of erosive energy of the ancient streams were not as long as that of the present, as they evidently did not cut as cañon-like depressions. The general surface of the country was not, therefore, as rugged as now, being hilly rather than mountainous, the difference in altitude of the general plane of the surface of the country and the stream channel depressions at corresponding points being much less than at the present time.

The gold in the channels is the product of the primary disintegration of the auriferous slates, talcose rocks, and quartz veins. Whether or not these disintegrated rocks were richer in gold, and the eroded portion of the veins more massive, is uncertain, but the erosive agencies of water and cold were undoubtedly much more powerful then. The theory of direct glacial erosion is hardly tenable, as no trace of it appears in the channels, and remains of flora and fauna are found that indicate, if not a temperate, certainly a subarctic climate. Le Conte says that the glacial erosion was prior to the formation of the channels, and was the greater disintegrating force.

The great changes in the location of the stream channels have been made by eruptive agencies. A secondary cause was their filling up with accumulations of gravels, sands, and clays. Enormous flows of trachytic lava (trachyte after Ashburner, Geological Surveyor, California—andesite after Becker, United States Geological Surveyor), volcanic ashes, tufa, and mud coming from the north filled up the channels at some points to several hundred feet in depth, turning the streams and completely altering the surface of the country. This covering up and obliteration of the surface was not the result of one season of eruptive activity, but of several, separated by enormous intervals of time only less than that which has elapsed since the final dying out of the plutonic forces. Discussion of this volcanic action is somewhat speculative, and deductions from the indeterminate phenomena are uncertain. As an opinion, merely based on examination and comparison, it is true the first of the flows in point of time seem to have consisted of trachytic lava, and to have covered the greater territory; that there then followed a long period of inactivity of the interior forces, during which the streams adjusted their channels to the changed topography. The first flows probably did not completely divert the streams, except at a few points, but merely raised their beds and changed the character of the channel deposits, the latter becoming largely lava. The period of inactivity was in time followed by another display of the plutonic forces, and in its turn by a period of quiescence. This sequence repeated several times, but with a diminishing power and range of the eruptive energy confining it more and more to the northward, and with lengthening intervals of repose, finally ended in the complete cessation of the eruptive energy. These latter flows, in addition to the trachytic lava, consisted largely of volcanic ashes and tufa, and volcanic mud. The channels and surface depressions generally, and some of the lower hill elevations, became more and more filled up and obliterated, until at the end of the last period of eruption a completely new topography was forming, the beginning of the present.

The lessening area to the south covered by the successive flows accounts both for the greater erosion of the eruptive deposits of the southern portion of the district, and for the greater aggregate depth and more numerous strata of the northern portion. It is probable that many of the existing river channels are the original ones cut deeper into the country rock, the volcanic flows not obliterating them at all, or only temporarily. This is particularly the case in the lower courses of the larger streams. The geological time of the end of the eruptive period was probably in the earlier quarternary, prior to the glacial epoch or age of ice. During it and since then has been the erosion of the existing river system. This, as before stated, is a system of tremendous gorges and cañons cut down through the surface volcanic deposits, the drift-filled old river channels, and from a few hundred to three thousand feet into the country rock. An erosion so stupendous could hardly have been made by the narrow, small flowing streams now in the bottom of these cañons, conceding almost any geological lapse of time. Only glacial action followed by great torrential streams can account for it.

The old river channels now are—as the result of the eruptive flows first filling, then denudation by glacial and stream erosion, depressions in the surface of the country rock filled with river sands, gravels, and clays, and capped with lava, volcanic ashes, and tufa, with possibly wash gravels lying between the volcanic flows—the remains of stream erosion in the interval between the flows. The depth of the gravels on the bedrock will vary between limits of nothing to three hundred feet; the depth of the

volcanic flows and other gravel deposits from nothing to fifteen hundred feet; though at no two points would exactly the same deposits, either in quality or relation, be found. The following data from the shaft of the Gray Eagle Drift Mine, Sec. 6, T. 13 N., R. 10 E., M. D. M., near Forest Hill, Placer County, is typical, and well illustrates the phenomena of several of the eruptive periods and the stream flows of the intervals between. Beginning at the surface, in sinking, the shaft passed through—

Red soil and loam	10 feet.
Soft gray volcanic ash	31 feet.
Hard gray lava, containing angular fragments of slate	80 feet.
River wash, sand and gravel in alternate strata, principally sand	34 feet.
River wash, gravel and sand in alternate strata, principally gravel	30 feet.
Yellow water sediment, pipe clay	25 feet.
Loam, fine black sediment, containing leaves, logs, etc.	10 feet.
Large bowlders, water worn	10 feet.
Hard, chocolate-colored lava	60 feet.
River wash, gravel and sand	10 feet.
Hard, chocolate-colored lava, containing logs, some petrified	20 feet.
River wash gravel	7 feet.
Hard, chocolate-colored lava	25 feet.

At this point the country rock is struck sloping down, showing that the bottom of the channel has not been reached. On and in this rock gold was found.

In this particular case there are four distinct lava flows determinable and four river flows in substantially the same channel. Not till the channel became full by the last volcanic flow did the old stream take an entirely different location. Comparatively few shafts have been sunk through these lava flows, the mining of the auriferous gravels underneath being most practicable through tunnels, and in the sinking of the shafts but little attention has been paid to keeping a record of the character of the ground passed through. However, in the working of some of the drift mines through tunnels, several of these lava flows have been located far underground, not superimposed one on the other, but filling channels that have cut through and crossed older channels filled with older lava flows. In the Bald Mountain Mine, at Forest City, Sierra County, the channel being mined was crossed and cut through by another channel about five hundred feet wide. This latter was filled at the bottom with a kind of volcanic mud and contained no gold. In the Mountain Gate Mine, at Damascus, Placer County, a wide white quartz channel was found to be cut through and crossed by another channel over five hundred feet wide and sixty feet lower at the crossing. This last channel, unlike that in the Bald Mountain Mine, contained auriferous blue gravel (almost exclusively slate) from six to fifteen feet in depth, directly overlaid with a hard, compact lava. In the Paragon Mine, at Bath, Placer County, there are three distinct determinable channels. First, the lowest and original, a blue gravel channel lying directly on the country rock. Second, an upper channel one hundred and fifty feet above the first in an elevation and having the same general line of flow. Between the two are alternate layers of wash gravel, sand, and pipe clay. Third, a channel crossing and cutting through the second, but not down to the first. This last is filled with a lava flow.

Some of these old river channels are filled to depths of several hundred feet with gravel, sand, and pipe clay, all river deposits, which extend to great widths and far beyond the limits of the lowest channel depression. These immense accumulations of gravel and other detrital matter, in a less degree than the eruptive flows, have still been the causes of changes in the location of the channels. An example of this kind of change, which is

more than usually marked, exists in the channels in the vicinity of Forest Hill, in Placer County. Four miles above Forest Hill there is only one channel traceable by surface indications; a mile nearer Forest Hill it seems to have had two distinct beds and locations. One of these runs south through the Paragon Mine, in which it has been followed for almost eight thousand feet, thence cut off and eroded away for over a mile; by Volcano Cañon it reappears as the extremely rich front channel of Forest Hill, having there a southwesterly course. The other, first having a southwesterly course till it is a mile west of the Paragon channel, then turns south, running through the Mayflower Mine, in which it has been followed for about two thousand five hundred feet, and keeping the same general direction it finally joins the other about a mile and a half southwest of Forest Hill. It seems almost impossible that both of these should have been made at the same time, but they are undoubtedly the work of the same stream, though the points of parting and reuniting have as yet not been found. Their common origin shows itself in the similar character of the gravel wash in both, and the similar character and yield of gold; also the widths of the beds of the channels are practically the same, and the elevations of corresponding points in these beds in agreement. The extreme rise of the surface of the country rock between the two channel beds, so far as known, except at a few points of no extent, does not appear to have exceeded one hundred and fifty feet.

The theory (an opinion) of these two channels is, that the first cut out by the stream became, in the end, filled with gravels and other water deposits till the water flow was forced over the low elevation between into the channel of a tributary, which it cut out and made into the main channel till it in turn became filled with gravels and detrital matter up to the level of the other. From this time on, the location of the channel was probably not permanently fixed, as wash gravel of similar character is deposited all over the country rock between the two channels, and all contains some gold. What has already been noted as the second, or upper channel, in the Paragon Mine was, from its unusual richness in gold for gravel so far above the surface of the country rock, the probable location of the flow for a long period of time. Both channels, the country rock and overlying gravels between, are covered with two hundred feet depth of lava, on which is another deposit of wash gravel from twenty to fifty feet in depth, containing some gold, and over this a second lava and volcanic ash flow capped with the surface soil, from one hundred to three hundred feet in depth.

As has already been stated, the filling in and covering of the old channel deposits with eruptive flows has not been uniform, nor has the subsequent denudation by the existing river system been the same everywhere. The portions of the channels in which were the largest detrital accumulation seem, as a rule, to have been lightly covered, and subsequently subjected to a more complete erosion of that covering, so that these larger channel deposits, or rather the remains of them, where they have not been entirely swept away and obliterated, are now in the form of gravel hills or "ranges," being the summits of the ridges between the river cañons. These large bodies of denuded channel deposits of auriferous gravels all containing a little gold, though of by far the greatest comparative richness at the bottom immediately on the country rock, are the source from which hydraulic mining has taken its enormous gold yield.

Before hydraulic mining had been developed as a distinct branch of the placer mining industry, the early miners working by the most primitive appliances the shallower of these "hill diggings," as they were then termed, and the edges of the deeper deposits, discovered that the richest gold-bear-

ing gravels lay immediately on the country rock and followed it into the mountain side. Unable, with the crude and imperfect appliances at their command, to remove the great masses of barren earth and nearly barren gravel overlying, the rich gold-bearing portion of the latter was followed by tunnels, broken out by the methods of underground mining, brought to the surface, and there washed for the contained gold. Nearly all of the great auriferous gravel ranges at Cherokee, Morris Ravine, and Oroville, in Butte County; La Porte, in Plumas County, and the adjacent district in Sierra County; on the ridge from French Corral to Moore's Flat, in Nevada County; and at Dutch Flat, Gold Run, Iowa Hill, Yankee Jims, and Todds Valley, in Placer County, were first mined in this manner. Subsequently to the first developments of this underground mining in these exposed deposits it was discovered that auriferous gravels also underlaid some of the lavas and volcanic wash, the table mountains at Mokelumne Hill and Sonora being notable discoveries of this kind. These deposits, being those exposed on the benches and slopes of the lava-capped mountains, were followed by tunnels and mined, and finally, inferentially, the existence of auriferous gravel under the lava, where there were no surface indications, was assumed, and tunnels run in the side of the mountain to locate and mine it. As early as 1853 the mining of the deep-buried auriferous placers through tunnels, and in a manner analogous to coal mining, was commenced. This branch of the gold mining industry soon became known as "drift mining," and was so distinguished from hydraulic, river, or bar mining. No statistics have ever been kept showing the amount of gold obtained respectively from drift, hydraulic, and surface mining, the latter including the river beds, but it is probable that in the aggregate, from the discovery of gold to the present time, the yield from drift mining will be close on to that from surface mining and somewhat in excess of that from hydraulic mining. As before noted, surface mining, except of the river beds, is practically ended; and it is not a factor in the gold product. The legal fight for years past against hydraulic mining has destroyed that industry, except on the Klamath River and its tributaries, so that at the present time drift mining is the leading branch of the placer mining industry in this State, and will undoubtedly continue to be so as long as placer mining is carried on. In the immense gravel deposits, wherever sufficiently rich in gold, drift mining will again take the position from which it was displaced by hydraulic mining. It is in this direction that the possible future extension of the industry will be made.

Before discussing the details of methods and appliances, a brief summary of the preceding expresses the conditions of drift mining, the problem that the methods and appliances are intended to successfully satisfy. The auriferous placer deposit is a river-washed gravel, most often lying in a narrow, gutter-like depression of the surface of the country rock, overlaid either with comparatively barren gravel and the detrital matters of fresh-water erosion, from a few feet to several hundred in depth, or with lava and volcanic flows to as much as a thousand feet in depth, or with both, in varying relative proportions and alternation, dependent on the surface denudation during the period of intermittent eruptive activity and since its close. Reliable surface indications of these ancient channel depressions are practically limited to the places where they are uncovered by erosion, or cut off or into by the present precipitous stream cañons. The present main river cañons have cut themselves down hundreds of feet lower than these old channels in all but a few localities. The Feather River at Oroville flows over the gravels, filling the old channel; and Bear River, just above Dutch Flat, flows in the lava cap of a buried channel.

The technical terms in common use among drift miners are comparatively few in number, but being in some instances words used out of their common, ordinary significance, an explanation of them is essential to a comprehensive understanding of the subject. These technical terms, alphabetically arranged, are:

Air tunnel, air drift, air gangway, or air shaft: A tunnel, drift, gangway, or shaft specially constructed for, or exclusively used to ventilate the mine.

Bedrock: The underlying country rock independent of its lithological nature.

Blocking out: Cutting up the pay lead into blocks by drifts and gangways to facilitate mining.

Breakout: A point where a ravine or cañon cuts into, but not through, a channel. Breakouts, inlets, and outlets are usually indicated by deposits of denuded channel gravels.

Breast: The working face of a prospect drift on the pay lead; the face of a gangway being mined.

Cap: A horizontal timber resting on posts and distributing their supporting power.

Cement: 1. The trachytic lava; 2. Any of the eruptive or volcanic flows indurated; 3. Auriferous gravel cemented till almost a pudding stone by pressure and the oxidation of iron pyrite.

Cement channel: A channel depression completely filled with lava, no auriferous gravel.

Channel: A stream-eroded depression in the bedrock ordinarily; exceptionally, in gravel deposits or in lava.

Chute: An upraise, vertical or inclined, through which gravel from the pay lead, or waste is dropped from one tunnel to another, usually from the channel into the bedrock main tunnel underneath; it is usually contrived so as to hold as in a box the gravel or waste dumped in it till discharged through a gate in the bottom into cars.

Drift: 1. A sub-tunnel running from the main tunnel to prospect for the pay lead; 2. A sub-tunnel run from the main tunnel across the pay lead to block out the ground and to facilitate its working; 3. Generally, a sub-tunnel.

Dump: The specially prepared place outside of the mine where the pay gravel is deposited preparatory to washing or milling it for its gold.

Gangway: A sub-tunnel or drift connecting two drifts in the pay lead, from which the ground is directly worked.

Incline: An inclined shaft or tunnel from the surface into the ground mined.

Inlet: The point where a channel is cut off by a ravine or cañon on the upstream end.

Lagging: Split slabs six feet long, from one to three inches thick, and six inches wide, supporting the spaces between posts and caps.

Mud channel: A channel depression completely filled with mud, probably of volcanic origin.

Nigger head: A rounded lava bowlder, found in some channels, and common on the top and sides of a lava-capped ridge.

Outlet: The point where a channel is cut off by a ravine or cañon on the down-stream end.

Pay lead: The part of the auriferous gravel in the channel containing an amount of gold that will justify its mining.

Pillar: Solid ground of the pay lead left next to the main tunnel or air drift as a protection against caves.

Pitch: Used in connection with the bedrock in the channel or rim to express descent.

Post: An upright timber receiving the pressure or weight on its ends, in any opening of the mine.

Prospecting: Used to qualify work merely intended to discover a pay lead in the mine, or to locate the channel.

Rim: The bedrock lying between the channel and the adjacent side of the mountain—generally the bedrock adjacent to the channel depression. It commences at the edge of the bed of the channel depression.

Rise: Used in connection with the surface of the bedrock in the channel or rim to express ascent.

Sill: A horizontal timber placed underneath posts, and distributing their downward pressure.

Slope: An incline.

Sump: An underground excavation into which the mine waters drain, and from which they are taken out of the mine by pumps, siphons, or buckets.

Top wash: A deposit of gravel, not in a channel on the bedrock, but resting on cement overlying the bottom deposit.

Tunnel: The nearly horizontal excavated opening from the surface into the mine.

Upper lead: A pay lead in a top wash or in the gravel deposit considerably above the bedrock.

Wash: Used indifferently in describing channel gravel, volcanic mud flows, or masses of lava bowlders.

The consideration of drift mining is naturally divisible into two parts: First, the exploration work to discover and locate the channel and pay

lead in it, to which the general term prospecting is applied. Second, the practical opening and working of the ground after discovery and location.

Taking up first the exploration or prospecting work. Experience has shown that of all the old channels, those that are the oldest, and that are invariably on the bedrock, not top wash channels, most surely contain gold in sufficient amount to justify prospecting for and working. Top wash channels, or sometimes a stratum of gravel in the channel many feet above the bedrock, are found to contain sufficient gold to make drifting profitabl but such instances are uncommon enough to be notable. Not all of the oldest channels contain pay leads, though they almost invariably contain some gold. The greater number of the pay lead channels are blue gravel channels, that is, the bedrock gravel is blue black in color as it stands in place and after being taken out of the mine. Its composition is not uniform, all the varieties of the country rocks seeming to have contributed to its bowlders and finer material, and quartz constitutes only a small percentage of the mass. These blue gravels are largely overlaid with white or red gravel composed almost entirely of quartz. A more unusual formation is a white bedrock gravel, such as is found at Damascus and Sunny South, in Placer County, composed almost entirely of quartz. The quartz gravels are not cemented nor near as compact as the blue gravels, the latter often having to be crushed in a stamp mill to get out the gold.

The pay lead in these channels is much more often than the contrary an uncertain quantity. It is very seldom coextensive with the channel, but takes its own independent course between the rims, and sometimes on them. Usually the pay lead is close to the bedrock, and if the latter is soft or creviced, in it. Sometimes the pay lead is the full width of the channel, more often it is only a comparatively narrow, ribbon-like line, meandering through it, first abutting on one rim, then on the other. It is not always continuous, being broken by barren places. Great variations in gold yield will occur in the same pay lead, due principally, it may safely be assumed, to the currents of the old stream, but in part, at least, to the equally safe assumption that the gold, particularly that portion of it which is coarse and heavy, has not been moved very far from the location of its original quartz matrix. Occasionally, large bodies of pay gravel are found on the rims at a considerable distance from the channel. These were probably the deposits on the old bars and benches of the channel left far above it as it became cut deeper. The nature of the bedrock seems to bear some relation to the gold distribution, but probably not as much as is ascribed to it by many miners. A soft yellow slate is regarded as a favorable bedrock; the gold being found in it to the depth of a foot or more. Serpentine, on the contrary, is regarded as an unfavorable bedrock, though experience does not justify this absolutely. Granite is much like soft slate, the surface softening and allowing the gold to penetrate a foot or more. A rock full of seams and crevices and with a slightly irregular surface is considered better than a hard, smooth, water-worn surface.

In prospecting for a channel, if an outlet, inlet, or breakout can be found and identified, the location of the channel with sufficient certainty to run a prospect tunnel or sink a shaft is not a difficult matter. The principal difficulty to be contended with is the determination of the rise of the rim above the channel bed. This rim is not only the naturally rising bedrock on each side of the channel, but is a ridge across inlets, outlets, and breakouts—the latter even when close down to the channel bed. The explanation of this peculiarity is undoubtedly this: The bedrock, overlaid with several hundred feet in depth of gravels and lava, is subjected to an enormous pressure. At an outlet or inlet, or wherever close to the surface, the

pressure is relatively only a small fraction of that far underground. This difference, even in rock that does not swell, becomes, in the immense lapse of time during the denudation period, a geological force which has raised the rock at the outlets and inlets till it has become a natural stone dam or rim. This peculiarity has given to many of the smaller fragments of the ancient channels the form of basins, by which name they were known to the early miners. This cross rim at an outlet or inlet often shows by the richness of the gravel on it that it was originally part of the bed of the channel, and it was the following of this rich gravel underground that led to the discovery of many of the most important channels.

The miners followed the pay lead on the rim by tunnels or hydraulic washings till they found it pitching into the mountain, and thus, losing drainage or dump grade, found it necessary to run lower tunnels through the bedrock rim, instead of on it. These in turn were often found too high, and still lower ones were run, only in turn to be abandoned, if found too high. Whether the point of opening is at an outlet or inlet, necessarily has considerable to do with both the prospecting and final opening of the mine. An outlet is naturally the most favorable point from which to open a drift mine. The outlets are almost invariably on the south or west sides of the ridges, particularly for the main great channels. For the smaller channels their geographical relation to the main channels as tributaries will determine the question of outlet or inlet. Prospecting from an outlet requires much less work to obtain the necessary information on which to open the mine than where the prospecting is from an inlet. The proper method of prospecting is to run a tunnel through the rim, as near as can be determined in the direction of the channel, and far enough down in the rim, so that when it breaks through the bedrock it will be in the bed of the channel; or when prospecting at an inlet, so that it will be some distance under the bed. If, when it breaks through, the bedrock be found pitching away, it becomes necessary to follow the bedrock down till the bed of the channel is found. If this be successfully done, it will not be necessary to run a second prospect tunnel lower than the first.

There is always a possibility that the prospect tunnel may be lower than the channel, even when not so intended, or it may miss in direction and run off to one side in the rim. This latter is rendered the more probable in that there is rarely any guide as to the exact relative position of the line of cut off of the channel, or cross rim to the line of direction of the channel. To guard against these possible mistakes in depth and direction, it is advisable to make an upraise from the tunnel as soon as it is believed to be through the rim. The trial distance from the entrance to the tunnel at which to make this upraise is twice the distance from the entrance of the tunnel to the line of contact of the bedrock with the overlying gravel. From the point where it breaks through the bedrock the direction and rate of pitch of the rim can be obtained, and should the bed of the tunnel be missed any necessary change in direction of the tunnel can be made. A second upraise in connection with the first will usually locate the bed of the channel; if not, a third one, or drifts from those already made, are necessary till the bed of the channel is located. This once located, such prospect works in the shape of drifts to find a pay lead and its probable extent, the grade and direction of the channel, and the general character of the ground to be mined, can be constructed, and the necessary data for the opening of the mine for pay work be obtained.

The development being at an outlet, the channel will be prospected and worked into on the ascending grade, assuring the most economical and perfect drainage. At an inlet the prospect tunnel must be run relatively

lower, and therefore longer, in order to gain on the descending grade of the channel. The channel found, it must be followed further and its grade determined with all possible accuracy, before opening the mine for work. Prospecting at a breakout is more uncertain of successful results than either outlet or inlet, for the exposed gravel may be in the bed of the channel, or it may be far up on the rim several hundred feet higher, making it impossible to locate a prospect tunnel with even a moderate degree of certainty, as the tunnel is as likely to be put too low as too high. Probably the surest method of prospecting is to either run a slope on the pitch of the rim, or to sink a vertical shaft on the presumed line of the channel, the former being preferable, as there is less uncertainty as to its accomplishing its object—the location of the bed of the channel. It has the additional advantage that it may discover pay gravel on the rim on what were once the benches and bars of the old stream. The bed of the channel located, it is prospected by cross and lateral drifts to ascertain width, direction, grade, and the location, extent, and character of the pay lead.

The principal difficulty to be contended with in the prospecting for a drift mine, is the drainage of the underground water flow. This is, of course, practically nothing through a tunnel lower than the channel bed. If the tunnel be too high, and it be necessary to sink shafts or inclines from it to the channel, a flow of water is almost certain to be encountered. If the shafts or inclines be of no great depth and the flow of water small, a bucket on the windlass or a hand pump will keep the water down so that it will not interfere with work. It is more often the case, however, that not only is the flow too great to be handled by the simple means indicated, but even steam pumps of considerable power prove inadequate to lift it, rendering it impossible to get to the bottom of the channel. It is then necessary to run a lower tunnel, abandoning the work already done, though, drainage secured, it may subsequently be utilized for ventilation. With a shaft or slope the problem of drainage is a very important one, and is, as regards appliances, affected by the uncertainty regarding what the ultimate depth of the slope or shaft will be, and what amount of water will have to be handled. In a shaft it is advisable to put in a Cornish pump as soon as the influx of water becomes too great to be lifted by a barrel. The flow of water in adjacent mines is practically the only guide for determining the capacity, but a large margin must be provided for, as water-bearing strata will undoubtedly be cut that do not affect the flow from other mines. It is not at all desirable to have a steam pump in the shaft. If any accident happens stopping it, the water may come over it before it can be repaired. Again, it is a heavy, awkward piece of machinery to adjust and change from place to place in the shaft as depth is gained, and a considerable loss of power is unavoidable in sending steam from the surface. It has the further disadvantage of heating the air and vitiating it by the escaping steam and sprayed lubricating oil. In a slope, should a Cornish pump not be practicable, owing to the great length and irregular pitch, it will be necessary to use one or more steam pumps. The difficulty of handling them is not so great in a slope as in a shaft.

As a fact, all of the preliminary work of developing a drift mine, till pay ground is located and opened up, is prospecting. Practically, the tunnels, shafts, slopes, and drifts that have been used in prospecting are ultimately utilized for the working of the mine, as far as it can be worked profitably by means of them.

All channels have not outlets, inlets, or breakouts that can be found and identified as such. The relative probability as between an outlet and inlet may be determined if the indications are of a large channel, but it is

much more difficult to distinguish either from a breakout under any circumstances. In the case of a channel in which there is only a comparatively thin body of gravel, from a few inches to twenty or thirty feet in depth, covered by many hundred feet of lava and volcanic wash, the discovery of exposed gravel is a very difficult matter, as the quantity of it is small and likely to be covered with a considerable depth of soil. Even if these small deposits of gravel be found, they cannot be depended on as indications of the location of the main channel. Possibly they may be rim gravels, the channel itself being entirely eroded away. Such deposits, often of some magnitude, occupy points projecting out into the main river cañons and having apparently no connection with any other channel deposit, the fact being that the present channel is only the old one eroded deeper. Often it cannot be determined till considerable prospecting is done, and even a large part of the channel worked, what the relation of the discovery point is to the channel. A phenomenon somewhat uncommon, particularly in the Placer, Nevada, and Sierra County channels so far as observed, is the distortion of the channel beds by faulting so that the grades are reversed. This will explain the apparent reversal of the laws of deposit of the bowlders and drift in some of the channel fragments. In running streams the rule is to find the smaller pointed end of the bowlder pointing up stream; in the old channels this is sometimes apparently reversed, in reality it is the faulting of the country rock and consequent distortion of the surface which has made the appearance.

The considerations generally expressed in the preceding indicate how uncertain the prospecting work of drift mining is, even with a knowledge of the phenomena of the ancient channels. Without this knowledge, as the early miners were, it is easy to understand the numerous failures made. The occurrence of the gold seems to have been regarded rather as an accident of the particular locality than the result of the operation of the general laws of stream erosion and deposit. The theories of the miners and their practice were entirely regulated by the lesser local phenomena coming under direct observation, rather than aggregated and compared data concerning all the auriferous deposits. Hundreds of tunnels have been run, and hundreds of shafts sunk to find the gold where prospectors thought it ought to be, their opinions being based on their wishes instead of on the result of careful investigation of the surface indications of the section of country and of adjacent locations and developments of the gold-bearing gravels.

Naturally it has only been since the origin and character of the gold-bearing deposits have been understood that engineering science to locate and develop them has been available. Its utilization has been very much more recent, owing to the disinclination of the older miners to avail themselves of it. At first the application of engineering science was quite simple in character, consisting of obtaining the grade and direction of a channel deposit already developed, assuming the practical continuity of both, modified by any surface indications in the shape of breakouts or gravel exposed in its original bed that could be assumed to belong to the same deposit; and having thus determined a point of probable location in the projection thus made, it is prospected by means of a tunnel, slope, or shaft, as may be considered most desirable under the particular conditions. The Hidden Treasure Mine at Sunnysouth, in Placer County, was located in 1875 and 1876 in this manner. One of the owners of the Mountain Gate Mine, at Damascus, became convinced that the channel gravel being worked in that mine was identical with two isolated gravel deposits known, respectively, as the Gas Hill Claims and the Big Gun Mine at Michigan Bluff, the first

named being six miles south, the other nine miles south of the Mountain Gate Works. Proceeding on that theory, he obtained the grade and direction of the channel, projected it four miles to the south from the Mountain Gate Mine in the direction of Gas Hill, and toward the most favorable point in the line of projection constructed a tunnel to come under the channel a certain estimated depth, and to reach it in a certain estimated distance, provided it maintained the grade and line of projection. The trial projection proved substantially correct, and the channel was located in its anticipated position, though there was no surface indication of its presence. The Hidden Treasure Mine so discovered, has developed into one of the best paying properties in Placer County.

The celebrated Bald Mountain Mine, at Forest City, in Sierra County, was discovered by the application of the same principles at an earlier date. The Live Yankee Drift Mine had been worked through the ridge from Alleghany to Forest City, a distance of about a mile; on the Alleghany side the channel was cut off by Kanaka Cañon, on the Forest City side by Oregon Gulch. It was successfully projected across this latter, and the Bald Mountain Mine, under the mountain of that name, discovered. This latter, in its turn, led to the discovery of the Ruby Drift Mine, the continuation of the Bald Mountain Mine, three miles to the northwest of where the latter was discovered on the opposite side of the mountain. In the location of the channel in the Ruby claim other data than merely the grade and direction of the channel in the Bald Mountain were used, the application of engineering science approximating toward the present advanced methods.

Ordinarily, the location of a channel in the absence of surface indication is a complex problem involving a survey and engineering examination of a comparatively large territory. The ridge in which the channel is suspected to be located is often of considerable width, and there is but little in the way of opening in adjacent claims to guide toward a correct trial location. Under these conditions, and advisably in connection with any preliminary work intended to locate and open up any drift mine, the initial step is an accurate topographical survey of the country. This consists, first, of transit lines following the line of contact between the rim rock and cement or gravel, as the case may be. If this can be made continuous all around the presumed channel so much the better. If, as is usually the case, this would include a greater area of country than necessary, the transit lines follow the rim lines on both sides of the ridge and are connected by cross transit lines. Also connected with these are transit surveys of the underground works in adjacent claims. All of these lines are leveled. A plat is made on which are placed all of the transit lines, and the level notes in the shape of contours crossing the rim lines; also the lines of ravines, roads, and any other data that may be deemed desirable, are traced.

The problem of the location of the channel then presents itself as the determination of the lowest point of depression between the two rims. This would be on the assumption that the rims pitched inward from the line of contact at the surface, which would be sufficiently safe for trial if the distance apart of these rim lines at the surface were not too great, say within six thousand feet, or if the channel were not quite close all the way to one of them. If the distance between the rim lines at the surface exceed six thousand feet, being in some instances as much as sixteen thousand feet, there is space sufficient for two or three channels or for the existence of considerable elevations in the bedrock which would be completely buried by the overlying wash and cement. It is possible, too, that one of the rims should rise going into the mountain for a greater or less distance before commencing to descend to the channel depression.

To properly estimate the probability of existence of these exceptional conditions, and for utilizing the plat for projecting trial locations, the works of adjacent mines are of great assistance, for from them with some fair degree of accuracy can be determined the mean rate of pitch of the rims, the grade of the channel, its relative elevation, and approximate direction. With these data trial cross sections from rim to rim at several points can be projected on the plat, and the trial points of lowest depression so determined platted. If the adjacent workings do not give data which can be utilized for this purpose, it becomes necessary to assume a mean rate of pitch for the rims and a grade for the channels. With these trial cross sections are constructed as before, possibly several trial values being tested, till the cross sections locate the several possible points of channel depression with a fair degree of possible relation between themselves. Formulating the method of determining the channel point in a cross section line, the rate of pitch of both rims being assumed the same, it is as follows: First, the horizontal distance from the surface point of either rim to the channel point is one half of the horizontal distance from the first point to the point of intersection of the horizontal distance line lying in the plane of the cross section, with the bedrock slope line, projected if necessary, of the other rim in the same plane. Second, difference of elevation between either rim point and the channel point is the horizontal distance first obtained for the same rim point multiplied by the tangent of the angle of pitch of the rim. From the plat the distance between the two rim points can be scaled on the cross section line, also the difference of elevation between the same two points can be taken from the contours, interpolations being made if needed, as it is not necessary to plat them closer than twenty feet apart.

Except in probably wide channels (two hundred feet and upwards), no attention need be paid to the width of the channel bed in determining the elevation of channel points from the trial cross sections. In practice the graphical method of obtaining these points is sufficiently accurate, and has the advantage of rapidity. With the trial channel points platted, a profile of the presumed bed of the channel can be made using the absolute elevations obtained from the rim points, and its probability determined. Possibly, several sets of projections and profiles have to be made before the one of greatest probability is determined on. From the platted line of the presumed location of the channel and the surface contours, the most available line for a tunnel, or the best point from which to sink a shaft, can be readily located; also the approximate length of the one or the depth of the other can be determined. The subsequent location of the tunnel line or shaft point on the ground is a simple matter. Except under exceptional conditions, the tunnel line is always selected, the point of entrance on the surface being so placed that when the tunnel has been run with a light ascending grade to the presumed channel line, it will be from twenty to forty feet below the bed of the channel. In order to avoid being too high with the tunnel, it is advisable to run it so as to come at least twenty feet lower than the trial location of the bed of the channel. This additional depth is utilizable for working down stream. To give a greater assurance of certainty as to the correctness of the location of the channel, where the construction of long and costly tunnels is necessary, it is recommended that bore holes be drilled to the bedrock on the presumed line of the channel, and on a cross section line close to where the tunnel line is located. Their depth being known, the shape and elevation of the bedrock can be compared with the approximations and estimates of the surveys and plat, and inaccuracies in the location of the channel corrected. After the mine

is opened, the bore holes can be used for ventilation. Independent of any elaborate topographical surveying (as the writer is advised), a number of such holes were drilled on a mining claim near Gibsonville, in Sierra County, and the location of the channel line determined. Subsequent development by a tunnel verified the correctness of the location.

The writer has employed this method of engineering determination successfully in a number of instances. It was also applied by Ross E. Brown, E.M., to locate the up-stream portion of the cross blue-lead channel first discovered in the Mountain Gate Mine at Damascus, and already referred to in this article. The discovery point was a mile and a quarter underground, and so situated that, though its course, elevation, and grade were determined, the pitch of the rims could not be. A mile to the northeast the north line of contact between the bedrock and cement was picked up, traced, and surveyed for eight miles up the ridge known as the Forks House Divide. The corresponding south line of contact was traced and surveyed the same distance, the two lines being about eight thousand feet apart. On the south line traces of small channels and one important one in the Dam claim (probably an inlet to this channel) opened by a tunnel for several thousand feet, all being evidently inlets of tributaries to the Mountain Gate channel, were found. No main inlet of the main channel on either side of the divide was discovered, but the survey connections made from the underground discovery point in the Mountain Gate Mine with the underground works of the Golden Fleece Mine, five miles to the northeast, indicated that the channel in the latter was the continuation of that in the former. The problem was to locate the line of channel in the intervening country between these two points. These underground works being platted, the approximate distance by the presumed channel line between the two points was obtained, and this, with the difference of elevation, gave a mean trial grade from which the approximate elevation of intermediate points could be determined. The location of these points between the rims was determined by assuming a trial degree of pitch for the bedrock of both rims, and locating them accordingly. A check on the value given to the pitch of the rims was had in the comparison of the figures of elevation of the bed of the channel in the same cross section obtained, respectively, from the mean trial grade of the bed, and from the assumed mean pitch of the rims. The closer these two figures of elevation were to each other, the safer was the projection. In addition to the preceding, other data obtained by the survey coincided in locating the channel line nearer to the north line of contact. Finally, a satisfactory projection having been made, the shortest line of a tunnel was located from the north face of the ridge, the entrance being in a sharp, precipitous ravine.

The running of the tunnel showed that the true location of the channel line had been very closely approximated to at that point by the trial projection. The first upraise made at the two thousand four hundred-foot station broke through the bedrock directly against the cement, about forty feet up. The tunnel was then continued to the three thousand four hundred and fifty-foot station, and another upraise made. This last disclosed so great a rise in the bedrock from the first upraise that a third upraise was made at the two thousand-foot station, which at fifteen feet up broke through the bedrock into gravel containing gold in paying quantities. This point was on the north edge of the channel. Further development located the center about the two thousand one hundred-foot station. The success of this work led to the application of the same method of engineering investigation to a study of what is locally known in Placer County as the Forest Hill Divide.

Though the surveys and necessary investigation are by no means complete yet, sufficient has already been established to prove that the channel just described as being found in the Mountain Gate and Red Point Mines is continuous through almost the entire length of the Forest Hill Divide, from Hogs Back, ten miles northeast of Damascus, to Peckham Hill, three miles southeast of Todds Valley, a total distance by the line of the channel of about thirty miles. On this channel, in addition to the already noted mines, are undoubtedly the Turkey Hill Mine (now closed), the Paragon at Bath, the Dardanelles below Forest Hill, the celebrated Mayflower, two miles north of that town, and the Gray Eagle at Spring Garden, two miles west of Todds Valley. These at this time are the mines producing; in addition are many other claims in a more or less undeveloped condition, and some practically worked out after yielding enormous amounts of gold. Among the undeveloped or partially developed mines are the Hogs Back Consolidated, Indian Springs, Golden Fleece, Adams & Sellier, Georgia Consolidated, Baker Divide, Excelsior, Mountain, Spring Garden, and Big Channel. Among those that have yielded largely, but that are not now worked to any extent, are the Gove, Maine, Independent, Rough and Ready, Jenny Lind, and Mountain, all lying under the town of Forest Hill. This main channel seems to have had many tributaries, all rich in gold, and all, so far as determined, coming in from the east. On them are located many mines that have yielded large amounts of gold, notably those above Michigan Bluff and on the Deadwood Divide. At the present time the Dam Mine, south of the Red Point, is the most important.

The advantages of the engineering method of channel location over the uncertain haphazard work of the early miners, are such as warrant its application in every locality where drift mining is carried on, and further, to the examination of all unprospected ground in which it is possible for an auriferous gravel deposit to exist. By its use it is possible to determine in advance of doing any underground work on the claim—

1. The approximate location of the line of the bed of the channel.
2. The approximate elevation of the bed at any desired point.
3. The location of inlets, outlets, or breakouts, and a reasonable certainty of distinguishing between them.
4. If inlet, outlet, or breakout, the probable length of rim to be run through and the depth at which it must be penetrated.
5. If no inlet, outlet, or breakout, then the nearest point of the channel line to the surface for tunnel or shaft, as may be most desirable.
6. The determination of the size of the channel and the probable extent of its pay lead. This being of advantage in estimating the probability of yield sufficient to warrant the necessary outlay of capital in development.
7. The tunnel or shaft can be so located as to have the shortest possible length or depth with the greatest possible certainty of finding the channel, and of thereafter being permanently utilizable for working the mine.
8. The preceding make it possible to estimate in advance the probable expenditure that will be necessary to open up the mine, and to avoid any unnecessary expenditure, thus assuring the greatest possible economy both of opening and of working.

The entire drift mining district is covered with the evidences of failures to reach the buried gold-bearing gravels. Hundreds of tunnels, slopes, and shafts, abandoned after the expenditure of thousands of dollars, are silent witnesses to the inefficiency of the practice of the early miners in their search for the auriferous gravel deposits. In one example coming under the observation of the writer, a tunnel was run eight hundred feet into the bedrock of a mountain, the tunnel entrance being immediately

over a small channel, when an engineer's examination would have shown, first, that the location of the channel was at the starting point; second, that in the line of the tunnel there was no channel for two miles; and third, that the cement relied on as a channel indication was only a shell ten feet or so in thickness lying on the sloping bedrock, the great mass of it having been eroded by the present river cañon. On the same channel, containing gold only in sufficient quantity to justify development on a small scale commensurate with its probable yield, through imperfect knowledge of it, was expended in the aggregate $150,000. After the expenditure of the larger portion of this amount, an engineering examination disclosed, what it could equally well have done before, that the expenditure of only a fraction of that amount was warranted by the probability of return; and with reference to the work done, that certainly $60,000 of expenditure could have been saved. The gold yield would very nearly, if not entirely, have balanced the other $90,000 expended.

The cost of an engineering examination by the methods described varies, dependent on the circumstances of the particular mining claim it is desired to develop, from $500 to $5,000, sometimes exceeding the latter figure. Under ordinary conditions $1,000 is a safe estimate for the services of a competent engineer and the necessary field assistance. So independent are all of the drift mines, that the owners of adjacent mines, from the inspiration of self-interest, should not hesitate to render all assistance in their power to this kind of investigation. The cost of running a tunnel will average under all conditions about $12 a foot, so that the saving of eighty feet in the length of a tunnel will balance $1,000 of expenditure for an engineering investigation. The sinking of a deep shaft will average upward of $30 a foot—a saving of thirty-three feet in depth will balance the same $1,000. Aside from this, the certainty that the first tunnel will develop the ground, and be sufficiently low to drain it, will counterbalance several thousand dollars expense of preliminary investigation. In sinking a shaft, the knowledge of the probable depth carries with it the possibility of adjusting from the start the hoisting and pumping plant to the ultimate possible demands that may be made on it. In the development of a mine, in the knowledge of the writer, a large sum was expended in the sinking of prospect shafts, and a further much larger amount, unnecessarily, in a main working shaft, by reason of adding piecemeal to the hoisting and pumping plant from time to time, as the demands on it increased, all of which, in the aggregate amounting to at least $10,000, might have been saved by the expenditure of $500 for a preliminary engineering investigation, for which the conditions were more than ordinarily favorable.

A drift mine having been discovered by prospecting, and the probable extent and yield of its pay lead having been estimated, the opening and practical working of the mine bring in new conditions for discussion. The object sought for is to get the auriferous gravel out of the mine and subsequently obtain the gold from it at the least possible cost. This cost is made up of the following several items:

1. Prospecting, which includes all the preliminary work of locating the channel and discovery of its pay lead.

2. The cost of opening a main working tunnel, shaft, or slope, its maintenance and extension, the cost of cars and fixed power plant, and the buildings and appliances at the surface.

3. The cost of mining, which includes the cost of drifts and gangways, breasting out the gravel, conveying it to the surface, timbering the working ground, ventilation, and drainage.

4. The cost of obtaining the gold from the gravel after it is brought to the surface.

The first two of these items are the charges for dead work, that is work from which there is no direct return. To them the investor will add the cost of the mining ground, and interest on all expenditure till the mine is opened and in shape to be producing gold. Their aggregate is a fixed charge against the ultimate total product of the mine. It may be called the Construction Account, and, as such, is closed when the mine is ready to produce gold. The last two items are the cost of mining, or running expenses. Among the miners, and in their representations as to the probable profits to be realized, it is not usual to make the most important distinction between the "cost of mining" and the "expense of working the mine." A drift mine may pay a considerable profit over the "cost of mining," the profit balance between running expenses and gold yield, while the total yield will fail to reach the "expense of working the mine." Practically, if there be a profit balance over running expenses the mine is worked, even though it be improbable that the total net profit will be as much as the fixed charge of opening the mine, thus the Construction Account becomes a charge against the net profits over the running expenses.

First considering the construction account. This necessarily must aggregate as small an amount as possible, consistent with the proper opening of the mine, as there can be no great degree of certainty of the net yield of the as yet undeveloped auriferous deposit. The methods of prospecting have already been considered in detail. Its cost, so far as the location of the channel and the determination of the best point from which to develop are concerned, is limited to the expense of the surveys and engineering examination, including the drilling of any bore holes needed in the investigation. Bore holes cost from 50 cents to $4 a foot, depending on the number drilled and the tubing used. After this preliminary work is completed, any underground prospecting, either for the channel or pay lead in it, is really an incident of the opening of the mine to the producing point, all the work done being on improvements intended for permanent use.

For the permanent working opening of the mine a tunnel, shaft, or slope is necessary. The tunnel is almost invariably the construction advisable. It should be so run as to be under the bed of the channel at the lowest point of the latter it is designed to mine, in order to assure natural drainage and to make it possible to take the auriferous gravel out of the mine without having to raise it. Working up stream in a channel with a uniform grade, this main tunnel can usually be run on the surface of the bedrock. Working down stream, or up stream where the channel bed is irregular or the ground more or less unsafe, the tunnel is run in the bedrock underneath, or in the rim to one side of the channel. From the entrance of the tunnel its direction should be at right angles to the presumed line of the channel, and it should be kept straight and on a uniform grade till it reaches that line. Thence its direction and grade are controlled by the channel to a considerable extent. The tunnel entrance is usually in or close to the bed of a ravine or gulch, the point so situated possessing the advantages of a natural dump for the rock from the tunnel, on which can then be erected the necessary mine buildings, and for the washing of the gravel subsequently taken out of the mine. The grade of the tunnel to the channel, while it is desirable that it should be uniform, is not an arbitrary quantity. It may be as low as one fourth of an inch to a rod (sixteen and one half feet) or as high as ten inches to a rod, the

practice being largely determined by the character of the track rail, the weight of the cars, and the power employed to take them in and out of the mine. With T rail and small cars, capacity of one ton, using man power, one inch to a rod is ample; with horse power one fourth inch to a rod will answer, a single horse being able to pull ten loaded cars out of the mine with ease; and if the grade exceeds two inches the cars will run out by gravity alone.

As to the dimensions to be given to the tunnel there is great diversity of opinion among miners, and the practice varies correspondingly. The dimensions of the older tunnels approximate in clear width five feet on the bottom and three feet at the top, with a clear height of six feet. Some of the tunnels of the recently opened mines have dimensions of eight to ten feet width at the bottom and seven to eight feet clear height, the top being arched in untimbered rock, or having a clear width of three and one half to four feet in timbered. The convenience of the larger tunnels over the smaller is undeniable, and results in larger aggregate savings in the time of the men employed in the mine when going to and from work, and in a measure protects them from the liability of petty accidents. While this is conceded, the point at issue is the relative initial cost. This cost is made up of the cost of breaking down the rock, which includes drilling and powder, and the cost of taking the excavated rock out of the tunnel. In soft rock timbering is also an item. Experience has demonstrated that greater advantage can be taken of the rock in drilling the blasting holes, and that it does not take any greater number of inches of holes drilled for a large tunnel than for a small one per foot of length, and that it takes, if anything, but little more powder. Holes can be drilled deeper and a breaking angle obtained in a large tunnel, so that the full effect of the powder is obtained. In a small tunnel it is difficult to get a breaking angle, and a deep hole is more liable to blow out. The cost of breaking the rock is often actually less for the large tunnel than for the small one. The moving of the rock may cost more in a large tunnel, as the quantity is so much greater. For a tunnel six feet high, five feet bottom, three feet top, the rock in place per running foot measures twenty-seven cubic feet; broken down, about thirty-one cubic feet; in a tunnel eight by eight feet, the top arched, the amount is sixty cubic feet in place, sixty-eight cubic feet when broken down; and in a tunnel eight feet high, ten feet bottom, top arched, the figures are, respectively, seventy-five cubic feet and eighty-five cubic feet. In practice, if hand drilling be employed, one carman can remove the rock from a long tunnel as fast as it can be broken down, even if it have the extreme dimensions noted. If machine drills are used, and the ground be easily broken, a second carman may be necessary, and a longer time is needed to get the broken rock from the face, but this is far more than compensated for in the larger tunnels by the opportunity to work two drills at once.

The difference in the cost of timbering between the large tunnel and the small is very little, if anything at all. Timbers cost by the piece, the price depending more on the relative scarcity of suitable trees and the distance they have to be hauled, than on their length and size. If lagging are used the larger tunnel requires 20 per cent more than the smaller. As a general proposition it may be safely taken that the large tunnel will not cost per running foot to exceed 10 per cent more than the small one, and that to offset this there will be at least 20 per cent gain in the rapidity of the work with hand drilling and 33⅓ per cent with power drilling.

The speed with which a tunnel can be made and its cost are almost entirely dependent on the kind of rock penetrated. In serpentine, by

double hand drilling, timbering being necessary by reason of the seamy and blocky character of the rock, which has little coherence, the cost will average $4 a foot for a tunnel eight feet wide on bottom, three and one quarter feet on top, and seven feet high in the clear. Of the $4 (the labor costing $2 50 a day), $2 85 is for labor, including one carman and blacksmithing, 65 cents for superintendence, 30 cents for powder, and 20 cents for timbers and lagging. A 30 per cent nitro glycerine powder will produce the best results in blasting. A nine hours' shift of four miners, one carman, and blacksmith, working half time, will excavate and timber between four and five feet of tunnel. It would not be advisable to use machine drills in this kind of rock. In hard, compact, metamorphic limestone and in granite only, a much less rate of progress is possible. By hand drilling in the limestone the rate of progress, no timbering being necessary, would not average over one foot per shift, the drilling being very difficult, and the rock requiring a higher grade of powder and more of it. The cost per running foot would be from $15 to $22. In granite, somewhat better results are possible, the rock both drilling and blasting better. The cost per foot would be from $10 to $18, dependent on the variations of hardness in this rock. Machine drilling in the limestone is more expensive, but more rapid than hand; the cost would go as high as $25 a foot; the rate of progress to two and one half feet a shift. In granite, the cost of the tunnel by machine drilling would be about the same as by hand, but progress would be twice as rapid, as four feet a shift could be made. The rocks already noted, serpentine, limestone, and granite, are exceptional, the common bedrock being slate in every possible degree of hardness, from the soft talcose and almost decomposed strata to hard, compact, blue slates, resembling the traps and greenstones. Through these, cutting the stratification at every angle, have been run nine tenths of all of the drift mining tunnels.

The greatest variations in the cost per foot exist, together with equally wide divergences in the rapidity of excavation. Some tunnels have been run for $3 a foot, others have cost at the rate of $75. The estimate of probable cost of any proposed tunnel is very largely speculative, as there is no uniformity of quality in the different strata that one tunnel line may go through, nor even in the same stratum. Hand drilling, except in the hardest varieties of slate, is less expensive than machine drilling, but the latter is fully twice as expeditious in any quality of the rock. The angle of the slate strata with the line of the tunnel affects to a marked extent the cost of breaking the rock. If the stratification plane is at right angles or nearly so with the line of the tunnel the rock breaks to best advantage and with the least possible drilling and powder. Making first a breaking angle in the middle of the face, it is often possible to square up the face preparatory to making another breaking angle, by seam blasts alone, the rocks coming out in large blocks. If the stratification plane lie in the line of the tunnel, no matter how inclined to the vertical, the difficulty of breaking is greatest. Between the two extremes it is always possible to get a breaking angle at either top, bottom, or on one of the sides of the face.

In one tunnel under the direct observation of the writer, the dimensions of the tunnel being ten feet wide by eight feet high (full), the rock being very hard, but with the stratification plane at right angles to the tunnel line, the cost per running foot, hand drilling, was $7, and the mean distance made per ten hours' shift of three men was two and one tenth feet. The same tunnel, machine drills being used, afterwards cost from $10 to $18 per foot; the same quality of rock as that worked by hand at $7 costing about $13. In another tunnel, in much harder rock, compact, almost crys-

talline, and with no stratification planes, probably a greenstone, the dimensions being eight feet by eight feet, the cost was $10 60 per foot, the rate of progress for nine hours' shift of three men being ten inches. In this tunnel it was necessary to use 70 per cent nitro glycerine powder, as compared with 35 per cent powder used in the other tunnel. In same kind of rock, but with a flat seam at the top, the tunnel being made eight feet wide, nine feet high, the cost was $8 50 a foot; 40 per cent and 50 per cent nitro glycerine powder being used. Near Forest Hill, in a shelly light blue slate, the stratification lines being in the line of the tunnel, the cost per foot for a tunnel five feet bottom, three feet top, and six feet high, varied from $8 to $10, 40 per cent nitro glycerine powder being used. Another tunnel, dimensions six feet, three feet, and seven feet, in very similar rock, but running at a slight angle with the stratification planes, costs $7 per foot, the same grade of powder being used. At Iowa Hill a tunnel in very compact blue slate, and running in the stratification planes, costs $23 per foot for some hundreds of feet. The tunnel was of the same dimensions as the preceding, but the rate of cutting with three miners was only six inches for a nine hours' shift. The wide divergence between these figures of cost of making tunnel by hand drilling makes it impossible to give any general rule for making estimates on proposed work. For safety it is advisable to allow a margin of at least 20 per cent over any estimates based on the surface character of the rock or work in adjacent mines.

The results of practice would seem to indicate that closer estimates can be made on the cost of proposed tunnels where it is designed to use machine drills. A tunnel ten feet wide, eight feet high, and three thousand three hundred feet long, in rock varying in hardness and breaking quality, from a seamy brown slate, large breaking, to a dark-green almost cryptocrystalline rock, containing iron pyrite, breaking very fine, averaged in cost per foot $14, some of the softer rock coming as low as $12, and the hardest up to $17. Two three and one half-inch National drills were used, run by water power in winter and spring and by steam in summer. The first cost of the compressor plants, including the drills and piping to the tunnel entrance, was about $6,000, or $1 81 per foot for the tunnel already made.

By the courtesy of the Superintendent, Charles F. Hoffman, E.M., I am enabled to give some very instructive data from the results of the running of the main bedrock tunnel in the Red Point Mine, near Damascus, Placer County. The tunnel is eight feet wide and seven feet high, full measure; the rock is a moderately hard slate, seamy and large breaking, and usually easily drilled. The line of the tunnel cuts the stratification planes at an angle of 31 degrees. The first one hundred and eight feet, requiring timbering, were cut by hand, thereafter two three and one half-inch Ingersoll drills were used. The power employed was steam, steel boiler, fifty-four inches by sixteen feet, compressor, straight line, eighteen by twenty-six-inch cylinder; and the powder used was 40 per cent Giant and Safety Nitro. It will be noted that the boiler and compressor power were considerably in excess of the demands on them, so, not being strained, there were no breakdowns to delay work and increase cost. The full length of the tunnel constructed was three thousand four hundred and fifty feet, but the following tabulated figures include only the first two thousand one hundred and fifty feet of this to the channel, the figures being given for the weekly runs:

1886.	No. of Drill Holes	Average Depth	No. 1 Giant Powder, lbs.	No. 2 Giant Powder, lbs.	Per Shift Average Time Drills. Hrs.	Min.	Carloads per Shift	Progress per Day	Progress per Week	Total Distance	No. of Drills Sharpened	Sets of Timbers
July 3			50	250						108		25
August 7	60		25					3.71	26	134		
August 14	80		50	20				6.14	43	177		
August 21	50		75	47				3.28	23	200		
August 28	157	4.80	50	350	1	50	17.50	11.82	71	271	162	
September 4	172	5.17		250	1	10	19.19	12.00	84	355	105	
September 11	44	3.39		50	1	05	13.33	5.25	37	392	25	16
September 18	97	4.70		100	1	00	15.38	8.12	57	449	37	12
September 25	84	4.91		100	1	25	15.95	7.28	51	500	31	12
October 2	187	5.20		300	2	06	17.86	8.57	60	560	174	3
October 9	254	5.02		600	2	09	17.23	9.57	67	627	228	
October 16	246	4.57		450	2	12	17.61	9.29	65	692	304	
October 23	221	4.99		400	1	48	18.00	9.42	66	758	244	
October 30	276	4.60		550	2	11	13.33	9.29	65	823	325	
November 6	200	4.89		450	2	26	14.93	9.36	50	873	198	
November 13	226	4.96		550	2	21	15.76	9.00	63	936	312	
November 20	232	5.11		550	2	53	16.19	8.57	60	996	296	
November 27	230	5.10		600	2	01	18.66	9.00	63	1,059	250	
December 4	210	4.85		550	2	54	12.57	7.28	51	1,110	359	
December 11	210	4.84		400	1	43	16.28	9.00	63	1,173	95	
December 18	246	4.61		600	2	43	14.57	7.85	55	1,228	396	
December 25	247	4.68		550	2	37	14.00	8.57	60	1,288	343	
*January 1	124	4.59		500	2	12	19.50	10.00	40	1,328	180	
†January 8	115	4.76		350	4	10	11.80	7.00	23	1,351	214	
January 15	238	4.70		750	3	20	14.47	8.14	57	1,408	372	
January 22	249	4.88		600	2	40	15.19	9.00	63	1,471	379	
January 29	177	4.88		500	2	29	16.61	9.00	63	1,534	275	
February 5	212	4.56		450	2	10	16.33	8.75	60	1,594	255	
February 12	166	4.76		400	1	48	15.76	8.57	60	1,654	250	3
‡February 19	107	4.84		250	1	42	16.33	8.80	44	1,698	90	
‖February 26	135	4.72		250	1	36	16.58	9.79	62	1,760	195	
March 5	195	4.76		550	1	40	18.95	10.14	71	1,831	200	
March 12	222	4.59		500	1	43	17.48	10.29	72	1,903	235	2
March 19	209	4.51		550	3	09	11.14	7.29	51	1,954	282	
March 26	229	4.75		550	2	12	15.19	9.00	63	2,017	286	
§April 2	204	4.67		500	2	31	15.92	9.00	54	2,071	285	
April 9	223	4.77		500	1	20	18.66	11.63	80	2,151	121	

*Four days. †Three and a half days. ‡Five days. ‖Six and three fourths days. §Six days.

An examination of the preceding will show how wide the range of penetrability of the slate in the same tunnel line is liable to be. The depth of drilling the holes shows only slight variation, not over 8 per cent from the mean; but the number drilled weekly ranged between extremes of forty-four and two hundred and seventy-six, the average being one hundred and ninety-two, the extreme divergences being 77 per cent and 44 per cent from the average. Average powder per hole, two and thirty-one one hundredths pounds; extremes, one and three one hundredths pounds and four and three one hundredths pounds; percentages of divergence from average, 56 per cent and 74 per cent. Average time of drilling, two hours ten minutes; extremes, one hour and four hours ten minutes; percentages of divergence from average, 54 per cent and 92 per cent. Average number of carloads per shift, fifteen and seventy-six one hundredths; extremes, eleven and fourteen one hundredths and nineteen and fifty one hundredths; percentages of divergence from average, 29 per cent and 24 per cent. Average daily progress, eight and fifty-eight one hundredths feet; extremes, three and twenty-eight one hundredths feet and twelve feet; percentages of divergence, 62 per cent and 42 per cent. Progress in the most penetrable rock was three and sixty-six one hundredths times as rapid as in the least, and the cost per foot was in practically the same ratio, the figures

being about $6 58 and $22 70, respectively, excluding the proportion of charge for the power plant and for car track. The average cost was about $9 30 a foot, proportion of power plant, car track, and timbering excluded. The entire cost, all expenses, except proportion of first cost of power plant and surface works, was $12 40 a foot. Proportion of power plant and surface works was $6 66 a foot for two thousand four hundred feet of tunnel.

The figures of these tunnels, and others that have been run, make it quite safe to estimate the probable cost of a long tunnel, eight by seven feet, in slate, using power drills, at $14 or $15 a foot for the cutting alone. The timbers and lagging, if used, will cost 15 cents to 25 cents a foot, the expense of setting them up being more than offset by the greater penetrability of the rock where it is necessary to use them. The track, preferably T rail weighing thirty pounds to the yard, will cost 45 cents to 65 cents a foot laid. The power plant, including three and one-half-inch Burleigh or Ingersoll drills (three-inch will do for soft rock very well), compressor for water or steam power, as circumstances may determine, piping and blower for ventilation, will cost, set up in place, from $3,000 to $6,000, dependent largely on the accessibility of the tunnel to the transportation facilities. After the tunnel has reached the channel, the latter then controls it. If continued in the bedrock, it is kept as close as practicable to the channel line, and in advance of the channel workings. If run in the channel itself, the bottom is cut a foot or two into the bedrock, dependent on its hardness. If not continued in the bedrock, or directly in the bed of the channel, its indirect continuation is run in the channel. An upraise with a chute for the mined gravel is the usual connection between the two. However, from the time it reaches the channel its extension in any form does not belong to the construction account, but to the account of running expenses. If run in bedrock, the cost will be about the same per foot as the tunnel construction already described, as it will be a permanent improvement. In gravel and bedrock the cost is not likely to be so great, and will be partially repaid, at least, by the gold yield of the gravel taken out. Timbering is usually necessary, and it is usually advisable to leave pillars of solid unbroken ground on both sides to protect the tunnel against caves.

The final charge against the construction account is for the necessary surface plant to separate and obtain the gold from its gravel matrix. What this shall be is not fully determined till the main tunnel has penetrated the channel and the pay lead has been discovered and prospected. Should the gravel be found soft and uncemented, slacking and breaking up readily on washing or exposure to the air, a dump, sluices, and water supply, under a small head, constitute the plant. Should the gravel prove hard, cemented, and either not at all or very slowly air slacking, it is worked in the stamp batteries of a quartz mill, which, when used for this special purpose, is termed a "cement mill."

The tunnel entrance being in or near a ravine or cañon, the gravel dump is built in it; or, if no ravine is at hand, in the most convenient location to the tunnel entrance. It consists of a heavy plank flooring, having two slopes to facilitate washing the gravel, one from the sides inward to a sluice box running through the middle, its pitch being immaterial and determined by convenience of construction, the other with the grade of the sluice box, one in ten or twelve. This flooring should either be sheathed with light plate iron or plank that can be taken out and renewed when worn out. From the edges of this flooring walls of heavy timber and plank are built up, giving the dump the appearance and utility of a large bin. The area of the flooring and the height of the walls are regulated by the desired capacity of the dump. In altitudes above the snow line, for the protection of the men, it is cus-

tomary to cover the dump with a roof or building of some kind, and also the track leading to it from the tunnel entrance. A smaller dump than the preceding is constructed at the same time as the main one, for the special purpose of prospecting gravel coming from different parts of the mine. If there is an ample water supply that can be used the gravel is washed one or more times every day, or as fast as it accumulates in the dump, making it unnecessary to have the latter of very large capacity. With a short, or rather with an intermittent water supply, dependent on the season of the year, a dump of large capacity to store the gravel must be built, or the mine is compelled to limit its production to the amount that can be washed by the water available. At the Bald Mountain Mine the storage dumps for the summer output of the mine were of twenty-five thousand carloads capacity, but even with this the mine could only be worked to one third of its winter yield.

For mines from which very large amounts of gravel are taken daily, a special discharging arrangement for the cars at the dump is of very great labor-saving advantage, and, indeed, almost necessary to allow of handling the gravel fast enough. This involves the use of specially constructed cars. At the Hidden Treasure Mine there is a dumping chair, operated by a hand lever, by means of which one man is able to dump two hundred cars in a ten-hour shift and at the same time break and make up the mine trains for the carman. The dump at the Red Point Mine is fitted up with an equally efficient discharging gear, the lever in this being operated by the foot. The sluice boxes beginning in the dump are continued beyond it a convenient distance and discharge into the ravine, in which are placed additional boxes, undercurrents, and tailing dams, all designed to recover the fine gold that passes the initial string of boxes. The special utility of the dams is in impounding the tailings until they are air and water slacked sufficiently to free the gold cemented to the gravel and clay matrix. The boxes are twelve, sixteen, or twenty-four inches wide and of equal depth, and have a grade of ten or twelve inches to twelve feet. The bottoms are fitted with riffle bars that can be removed and reset rapidly.

The water supply is usually the serious difficulty to be provided against, particularly in summer. The natural water in the ravine in which the dump is located, and, if needed, from adjacent ravines as well, is diverted into a reservoir tank and supplemented with the mine drainage water, the latter sometimes being sufficient in itself. It is preferable to have this reservoir tank, even where a water supply from a canal is directly available. This tank is built close to the tunnel entrance, the floor of the dump being from twenty to sixty feet lower, in order to have a hydraulic head in washing. A convenient size for the tank is to have it twenty-four feet square and six to eight feet deep, though it is sometimes built larger. The size referred to will hold sufficient water to give a forty-inch flow of water for an hour. From the tank an iron pipe six inches in diameter goes to the lower end of the dump, and is shut off there with a gate, so as to be under control of the pipeman. The piping nozzle is connected with the iron pipe by ten or twenty feet of canvas hose.

The arrangement of the plant at the Red Point Mine is specially to be commended, and a similar construction being usually practicable at other mines, a detailed description is given. The floor of the dump is sixty feet long and forty-eight feet wide. The height from the sluice to the dumping chair in the floor of the house covering it is thirty-six feet. The side-walls, built on heavy framed timbers, slope inward twelve feet to the floor of the house, twenty-four by sixty. In the lower right hand corner of the dump floor is a small room arranged for panning and cleaning the gold as it comes

from the sluices. The capacity of the dump is four hundred carloads of one ton each. The house overhead is utilized as a storeroom for supplies. Outside the building is a small, twenty-carload capacity dump, for prospecting, so arranged as to discharge the tailings into the main dump. The reservoir tank, twenty-four by twenty-four by six and one half, is built in the made ground at the tunnel entrance, giving thirty-five feet head to the washing stream. The first string of sluices extends one hundred and fifty feet beyond the dump, and drops the tailings fifty feet into the bed of the ravine, in which are more sluices, an undercurrent, and several tailing dams.

If the pay gravel be hard and cemented, requiring crushing to separate the gold, a stamp mill is an essential part of the plant. In construction and general arrangement only slight differences are made from the ordinary form of wet crushing gold quartz mill, and the cost of construction is practically the same. In its arrangement the cars from the mine discharge into a bin, the floor of which is on a level with the battery feed. The feeding is usually done by hand, large lumps being broken up with a hammer, and cobbles thrown into a waste dump. The batteries have a front discharge through a three sixteenths inch mesh wire screen on to a silver-plated apron. Thence the pulp passes under rubbers designed to brighten any coated gold that may have passed the plated apron, and from them into a string of boxes with riffles, from these latter passing off as tailings. The quantity of gravel that can be milled per stamp per day depends on its hardness. The gravel from the Paragon Mine is treated in a ten-stamp steam power mill. The stamps weigh nine hundred and fifty pounds each, drop nine inches ninety-four times per minute; battery screens wire, three sixteenths inch mesh; the total crushing each ten-hour shift varies from nineteen to twenty-seven carloads of two tons each. At the Dardanelles Mine there is a five-stamp steam power mill (water power in winter). The stamps weigh nine hundred pounds each, drop nine inches ninety-five times per minute; battery screens wire, three sixteenths inch mesh. Total crushing per ten-hour shift, twenty carloads of one and three tenths tons each. The work per stamp per twenty-four hours by the Paragon mill is nine and twelve hundredths tons to twelve and ninety-six hundredths tons, and by the Dardanelles mill twelve and forty-eight hundredths tons. Practically all of the gold is caught in the batteries. At the Paragon mill, after a year's run, only $300 was cleaned up from the rubbers, and $100 from the boxes. A number of mechanical devices have been invented to take the place of the stamp mill for crushing gravel, most of them working on the principle of tearing the cemented gravel apart instead of crushing it to sand. Their principal advantage is in their relatively greater capacity for work over the stamp mill.

The opening and working of a drift mine through a shaft is only advisable under conditions which make a tunnel impracticable. It may be that a shaft of no great depth, comparatively cheap and rapid of construction, is possible where it would require a very long, costly tunnel to reach the same gravel deposit. The element of time is decidedly in favor of the shaft, as against a long tunnel. Also the cost of construction can be estimated with some certainty, as the hardest ground it will pass through will be the lava cap, if any, at the shaft point. Its disadvantages are found in the expense of drainage and lifting gravel during the permanent working of the mine, this increase in running expenses more than counterbalancing the decrease of the construction account. Also the possible gross gold yield is decreased, as the limit of gold yield below which the

mining of the gravel is unprofitable, is a much higher figure when the mining is through a shaft than when through a tunnel.

Where the mine must be opened by a shaft it is advisable to make the construction thorough and permanent from the beginning. The shaft point being located by the preliminary engineering investigation and prospecting, the sinking is done as far as practicable with horse power hoisting gear, the influx of water being taken out by the bucket as far down as it can be done without delaying the work of sinking. This point will be from forty to one hundred and forty feet in depth from the surface. The power plant for hoisting and pumping is then set up, being proportioned, so far as hoisting is concerned, to lifting the gravel from the estimated depth the shaft will have when completed, and for pumping to the probable amount of water that may be encountered when the mine is fully opened, a considerable margin of safety being advisable in providing for this, so that there will be no straining of the machinery. An additional margin of power is provided for to secure ventilation. Of course, wherever obtainable, water power is used, being far more economical. Most of the existing plants are, however, steam, the shafts being on the summits of the ridges, where it is not possible to get the necessary pressure for use of water.

While sinking the shaft and prospecting, a bucket can be used to best advantage in removing excavated material; afterwards in mining a cage on which a car can be lifted is preferable, as it saves one and possibly two handlings of the gravel. The preferable style of pump is the Cornish, both in sinking, as most readily adjustable to the conditions of changing depth, and afterwards as being able to control an increased flow by increase of speed alone, and as having less liability to breakages. The influx of water comes from the several gravel or diluvial strata passed through in sinking. This can be cut off from the bottom of the shaft by sumps, and pump stations placed where the flow is cut by the shaft. The shaft should be built in two compartments, one for the hoist and the other for the pump and man-way. It is timbered with framed square timbers, lagged on the outside and boarded on the inside in the hoisting compartment. The size in the clear is four and one half by nine feet or five by ten feet. The size of the framed timbers is eight, ten, twelve, or fourteen inches square, and the sets are placed four, five, or six feet between centers, as controlled by the character of the ground passed through. The lagging is two inches thick. In lava there is no strain on the shaft, but some of the gravel and sand strata cut through are more or less liable to loosen and some of the slightly indurated clays are apt to swell. The cost of sinking a shaft can be safely estimated for the first fifty feet, $10 a foot; for the second fifty feet, $20 to $30 a foot; for the next one hundred feet, including the power, hoisting, and pumping plant, $50 to $60 a foot, and thence up to four hundred feet depth, from $60 to $75 a foot.

Though a favorite method of opening a mine by the first drift miners, a slope is the least advisable now, and would only be employed under special conditions of economy of construction, as, for example, in working from a flat, too extensive to be tunneled under, to a channel underneath a precipitous mountain slope, which would involve too deep a vertical shaft; or in mining from an inlet where neither tunnel nor shaft is practicable. Usually the conditions that indicate a slope as the most direct method of opening the mine can be better satisfied by a shaft and thence a tunnel from its bottom. In practice, if an extensive body of pay gravel is developed by a shaft or slope, a tunnel is subsequently run to mine it. This was done in the Derbec Mine, near North Bloomfield, Nevada County, a shaft three hundred and sixty-seven feet deep and a steam power plant

being replaced by a two thousand-foot tunnel. Also in the Mayflower Mine, at Forest Hill, a tunnel nearly six thousand feet long has been run to replace the shaft through which the discovery was made. At the present time no drift mine in the State is being worked through a shaft. A few are prospecting through shafts, with the intention of running tunnels if a sufficient amount of pay gravel is developed. The surface arrangements for working the gravel after it comes from the mine are the same in the case of either shaft or slope as already described for a tunnel.

The preceding pages have considered the dead work of development specially chargeable to construction account. With its completion this account is closed, and all subsequent work and expenditure is a charge in a new account: the running expense of working the mine. The expediency of the expenditure of the capital used in the construction account must be determined on in advance from the results of the preliminary engineering investigation and prospecting. Once laid out its return, as before noted, is from the net yield of the mine over its running expenses. These running expenses come under the several heads, as follows:

1. Opening up the channel or pay lead by main tunnel, drifts, and gangways. Prospecting for pay lead when it is lost.
2. Breaking out the pay gravel.
3. Timbering.
4. Drainage.
5. Ventilation.
6. Track, switches, upraises, and dumps in the mine.
7. Cars and motive power for moving the gravel out of the mine.
8. Working the gravel after being taken out of the mine.

The main tunnel, when in the channel and pay lead, is constructed in larger dimensions and more carefully than the drifts and gangways only intended for temporary service. If timbered, the best timbers are used and the work of setting them up is done so as not to require early removal. In hard, cemented gravel, requiring blasting, the drilling is single or double handed, power drills not being used. In wide channels, as a precaution against possible caving, a pillar of solid ground is left on each side of the tunnel, from twenty to forty feet wide, dependent on the stability of the ground. Where the working tunnel is in the bedrock underneath, following the line of the channel, the pillar need not be left, as the tunnel in the gravel becomes a main drift for only temporary use in mining the ground between its connections with the bedrock tunnel. These connections are made every two hundred to four hundred feet, as determined by convenience of working. The main tunnel in the gravel on the bedrock, and also the bedrock tunnel, are sometimes affected by the swelling of the bedrock, usually upward in direction. Under such circumstances very heavy timbering is advisable, and the floor of the tunnel must be cut down from time to time in order to keep it from closing up. The necessary excavation can be done without interrupting the working of the mine or the use of the tunnel, as the swelling rock is always soft and can be worked out without using powder. The main tunnel is kept as straight as possible and in the center or lowest depression of the channel. Drifts are run from it at right angles to the rims of the channel or the limits of the pay lead. These are timbered and lagged in soft ground, but in not as permanent a manner as the main tunnel. The distance apart of these drifts is not governed by any special rule. Both the main tunnel and cross drifts are used to prospect the ground and locate the pay gravel. This use will control the distance to some extent, but not absolutely. In the

pay lead the distance apart is decided so as to secure the greatest convenience of working.

In the Red Point and Hidden Treasure Mines, in which the pay leads are very wide, the drifts are one hundred and twenty feet apart. In wide channels these drifts are connected by gangways parallel to the main tunnel, the practice in their number and distance apart being equally flexible. In the Red Point Mine they are run sixty-five feet apart, thus blocking out the ground to be mined into rectangles one hundred and twenty feet by sixty-five feet. In the Bald Mountain Mine, at Forest City, the practice was to run both the drifts and gangway eighty feet apart, leaving a pillar of forty feet to protect the main tunnel. In the Hidden Treasure Mine only one gangway is run, connecting the ends of the drifts at the extreme limits of the pay lead as determined by the prospecting of the gravel from the drifts. This difference in practice is accountable for by the difference between the character of the mining ground in the several mines. In the Red Point it is hard and compact, and the openings, except in the breasts, require no timbering; the gravel, however, is not regular in the amount of the gold it contains, and closer prospecting is advisable to cut out ground too poor to pay for mining. In the Hidden Treasure the gravel is soft, the bedrock swells, and every opening requires timbering to protect it; therefore only absolutely essential openings are made for working, the gravel being so uniform in gold yield that special close prospecting is not needed. The Bald Mountain gravel was soft and as regular in yield as in the Hidden Treasure. The smaller blocks were doubtless made to facilitate the convenience of working, only four and one half feet of depth of ground being taken out. The cost of a main tunnel in the gravel drifts and gangways naturally has a considerable range as between different mines, but is practically constant in the same mine. In hard, compact gravel, requiring blasting, the cost of main tunnel, six by seven feet, will be from $4 to $7 a foot; of drifts and gangways five by six feet or six by six feet, from $3 to $5 a foot. In gravel not as difficult to drill as the preceding, but still requiring blasting, $3 to $4 for main tunnel, and $1 75 to $3 for drifts and gangways. In soft gravel, requiring timbering, the figures are about the same as those last given, the greater penetrability being offset by the expense of timbering. In some mines, particularly where pay gravel on the high rock of the rims is being prospected for, the drift for this purpose is run as wide as sixteen feet and as low as four feet in height, in order to cover as much ground as possible, and move as little waste. This method is, however, unsystematic, and not to be recommended for large mining operations.

In connection with the opening of the mine and mining properly belongs the consideration of the utility of trained engineering skill to drift mining. Already in this connection, with the preliminary work of location of the development works, has been shown the value of this skill. In connection with the permanent opening and subsequent working it is of equal service and value. Every drift mine should have an accurate working map, on a scale of twenty or forty feet to an inch, of its underground workings and their connections with the surface. On this map should be shown the tunnels, shafts, drifts, gangways, rims of the channel, and blocks of ground cut out for breaking down; also the location of air and water pipes and connections. On it can also be placed the figures of the estimated yield of the different blocks of unbroken ground, as determined from the prospecting and the figures of actual yield after working. The ground worked out from week to week can be marked on the plat by shading. A map so made is of great service in directing the main tunnel and prospecting

drifts in advance of the ground being mined out, and in making air and working connections. To facilitate the surveying the underground foreman should set points at all angles and intersections in tunnels, drifts, and gangways. These are best set overhead in the roof, as less likely to be disturbed by the mining operators. A wooden plug is first firmly driven in a short drill or gad hole, into this a ring or hook from which a plumb or lamp can be suspended.

The breaking out of the gravel, the mine being opened as described, is done from the faces of the gangways, or if there be none, from the faces of the drifts or main tunnel. In the Hidden Treasure Mine the side of the gangway toward the main tunnel is the working breast, and is broken down by the miners working the whole length of it at once to a distance of eight feet from the gangway. A new set of posts, parallel to the gangway, with caps and top lagging, is put in, timbering up the ground to the face. The track is then moved from the gangway close up to the breast, and more ground broken out as described. Not all of the gravel is taken out of the mine, but only the fine, the bowlders being piled back on the ground from which the track has been moved. A block is thus worked up to the line of the pillar thirty feet from the tunnel. The gravel being soft no powder is used. From one to two feet of soft bedrock and three to four feet of the gravel are mined out. The method described was also used in the Bald Mountain Mine, and, in fact, is employed in all the large, systematically operated mines, where the gravel is broken out without powder, and where the bedrock is soft and of comparatively even surface. In mines where the gravel is hard, and has to be broken out with powder, there is no special care taken to keep the breast faced up even, it being most economically broken down by working from the corners of the blocks. The drifts and gangways are kept open and the track is not changed, but the broken out gravel is shoveled out from the breast to the cars after separating the large bowlders. To make the shoveling easier temporary plank floors are put in. In ground with hard bedrock of very irregular surface the track is not moved up to the working face, but the gravel is shoveled out to it as already described. In narrow channels, where the cross drifts are not connected by gangways, the sides of the drifts and main tunnel, preferably the former, are made the working breasts, and the ground broken out from them.

A method in common use among many of the miners for working their ground, even where the pay lead is quite wide, is to mine its entire width in one semi-circular or curved breast without running a main tunnel ahead or cross drifts from it. The unsystematic and unnecessarily costly character of this method is evident. There is no opportunity to prospect the ground in advance of working it, and there are no reserves to keep up the output while exploring through a barren portion of the lead. Timbering cannot be done systematically; the main tunnel in which the track runs is not permanently protected against caves. If the ground is hard there is great waste of labor in drilling and of powder in breaking. The method is to be condemned under any conditions.

In blasting gravel in a drift mine the object is not only to get the full effect of the powder in the amount of gravel thrown down, but to pulverize it as completely as possible so as to free in a measure the gold. The best practice is to drill deep holes three to five feet, chamber them, and then put all of the powder in the bottom of the hole tamping it in tight. Experience will determine the proper load for the holes to produce the best results. A slow burning powder is preferable, proportioned to the tightness

of the ground. The usual strength used is from 30 per cent to 40 per cent nitro glycerine.

The output of gravel from a drift mine is measured by carloads; the size of the cars is not, however, uniform, so a comparison must take this difference into account. The cost of breaking out the gravel independent of the expenses of handling it afterward, or those connected with the opening of the drifts and gangways, timbering, and track, is controlled by the hardness of the gravel, expense for powder and candles, and the rate of miners' wages. The tabulated figures will show the cost in several mines, and furnish fair comparative data for estimating:

Name of Mine.	Candles per Ton	Powder per Ton	Carloads per Pick	Weight Carload—Tons.	Total Weight Broken Out.	Rate Miners' Wages	Cost per Carload	Cost per Ton.
Dardanelles	$0 02	$0 40	1.50	1.30	1.95	$3 00	$2 55	$1 95
Paragon	01½	....	1.35	2.00	2.70	3 00	2 25	1 12½
Red Point	01½	25	2.70	1.00	2.70	3 00	1 27½	1 27½
Hidden Treasure	01	....	4.30	1.00	4.30	3 00	71	71
Manzanita	01⅝	....	4.30	1.40	6.82	2 50	52	37

The Dardanelles gravel is hard, but it is worked in the curved form of breast condemned above. The Paragon gravel is soft, but worked out in an irregular manner only slightly improved over the preceding. The Red Point gravel is as hard as that in the Dardanelles, but the systematic method of mining employed makes it cost considerably less per ton. The Hidden Treasure and Manzanita gravels are soft, but completely unlike, the first named having a white quartz gravel, and the last a fine quartz gravel, with a large amount of sand and no waste to speak of. If the surface of bedrock is hard and left unbroken on breasting out the gravel, it is cleaned thoroughly, the crevices and surface being scraped with a special tool to remove every particle of gold, before the bowlder waste is thrown back on it. One, or at the most two men, can clean the bedrock of a large mine as fast as it can be uncovered by the breast miners.

The timbers used in a drift mine are obtained from the surface of the claim or from timber land near at hand. They are usually cut by contract and delivered at so much apiece—8, 10, 12, and 15 cents, dependent on the size, and the distance they have to be hauled for delivery. The posts, caps, and sills are cut from cedar, sugar or yellow pine, or spruce, and are relatively valuable in the order given. They are rough cut in length from six to eight feet, or more or less if so required, and from eight inches to fourteen inches square, rough hewn or split, or, particularly in the larger sizes, left in their natural shape with only the bark removed. The lagging is split from the same varieties of wood, one and a half to two and a half inches by six inches by six feet. It is cut by contract at so much per thousand—$8 to $12. Both timbers and lagging are allowed to dry and season where cut out of the trees. Before being taken into the mine they are dressed and cut by the carpenter for the special purpose for which they are to be used. The carpenter also prepares large numbers of wedges, which are used to brace the timbers into position.

The different timber men in the mines each have their peculiar method of framing the tunnel sets of timbers, and all seem equally efficient. In placing a set in position seats are cut in the floor for the posts to rest in, sills being rarely used. The cap is mortised at the ends into which the top of the posts fit. These sets are placed from three to six feet between

centers, dependent on the solidity of the ground they support. The lagging is driven in behind the timbers and towards the face. If not perfectly solid in place, wedges are driven in, always pointing towards the face. The size of the tunnel timbers and the inclination of the posts from the vertical depend on the ground, the size of the tunnel, and desired permanence of the work. The Bald Mountain tunnel was in soft ground; round timbers twelve to sixteen inches in diameter were used; the sets placed four feet between centers, and the inward inclination of the posts, two feet nine inches in a rise of six feet six inches, the tunnel being nine feet, three and one half feet, and six and one half feet clear dimensions. The usual sized timber employed is eight to ten inches in diameter, and the inclination of posts, one foot three inches to six feet six inches. In the cross drifts lighter posts are used, but the sets are framed and the construction similar to the main tunnel, except that only the top is lagged, unless the ground should be very soft and sliding. In the working gangways the posts are set vertical and the mortised end of the cap only covers half the top of the post, so that as subsequently other parts are set up in breaking out the ground as described, the same post will support the end of a second cap. Only the top is lagged. In breaking out the ground the timbering is similar in kind and construction to that in the gangways. In hard ground that is broken out by blasting comparatively little or no timbering is necessary. As a rule only posts are used, with or without caps, the latter not necessarily supported by more than one post. The caps are secured in place by wedges driven towards the working face to prevent the roof starting, and as a protection to the post during blasting. The actual cost of setting up timbers and lagging in working ground of a mine cannot readily be segregated from the cost of breaking out the gravel, as it is not usually done by a special force, but by the miners themselves under the direction of the underground foreman.

Drainage may or may not be a most important item of expense in working a drift mine. It is practically nothing where the mine is worked on an ascending grade through a tunnel. If it has to be lifted some of the various pumping devices are used. For a shaft, the Cornish pump has already been referred to and commended. For making short lifts, less than twenty feet in the altitudes at which most of the drift mines are located, a siphon can sometimes be employed, and requires but little attention. Underground, direct acting steam pumps are usually employed, the steam being brought from the surface, necessarily with a loss of power dependent on the distance. In the Mayflower Mine, at Forest Hill, Placer County, while worked through the shaft, six pumps were employed underground, some of them two thousand feet from the boiler supplying the steam. In addition to the great expense involved, it made a most unsafe plant, for the breaking down of one of the pumps destroyed the efficiency of all beyond it in lower levels of the mine. Sometimes water power is available for direct use underground.

In the Mountain Gate Mine, at Damascus, Placer County, the main bedrock tunnel is forty feet lower than the channel being mined, at the point where it is cut off by the deeper blue lead channel. The channel descending inward to this point, all its drainage, about forty inches, was collected at the inner end and utilized to run a forty-foot overshot water wheel, which gave power to pump and hoist from the cross channel sixty feet lower.

In the Turkey Hill Mine, near Michigan Bluff, water was brought in through the air shaft, three hundred feet deep, falling on an overshot water wheel, and furnishing power to pump the water from the deep working to

the level of the main tunnel, whence it reached the tunnel entrance by natural flow. In this instance only a fraction of the effective power of the water was utilized, as it was allowed to fall free in the shaft. Another device that can be used efficiently if water power under high pressure can be had, is an arrangement on the principle of the hydraulic elevator and Bunsen pump, by which the water power is used directly to obtain a suction and elevating force. The cost of putting in the plant for the water power devices is not very large, and they can be operated cheaply, the last described at only the cost of the water for power, as it requires, once started, no attention whatever. The water power pumps require more or less repairing and examination to keep working well. The first cost of steam pumps and their connections and the expense of operating are a heavy charge on the gravel mined. Their employment is condemned except for very rich ground that can be drained by no other means.

Ventilation of drift mines is an important but rarely costly matter. The mine waters assist in this to some extent. The devices employed are direct air connections with the surface by bore holes, shafts, slopes, or tunnels, or combinations of them, by which a current enters at one opening of the mine and passes out at another, the draught being natural or forced by fire or falling water. In the mine an arrangement of doors directs and controls the air current through the drifts and breasts. With only one opening to the mine the ventilation is by a fan or air blower at the tunnel entrance, forcing fresh air to the working face or withdrawing the vitiated air from it by a pipe line. If there is water power from the mine waters or other source of supply, the blower can be driven by it at a little expense. Steam power for this special purpose is not advised, but if a steam plant is necessarily utilized for other purposes, it can be employed to run the blower without any additional expense being incurred. Air shafts and drifts are so constructed as to cost as little as possible. The shafts being raised from the workings of the mine to the surface are lightly boxed by timbers and lagging, and both the ground cut and the water flow reach the foot of the shaft without handling. Unless the shaft is over one hundred feet, only one compartment is necessary, the size of the shaft being two and one half feet by five feet in the clear. If over one hundred feet, it is advisable to make in two compartments, one with ladder way, the other for the excavated material to fall through. Practically this last is arranged with a gate at the bottom, and kept full to the top with the waste, making a floor for the miner to stand on while working, and preventing danger to the timbering from the falling rock.

A portion of very deep shafts is excavated from the surface. It is not readily practicable to raise much over three hundred feet or sink over one hundred and fifty. In raising, if blasting is done, it is advisable to cut short drifts out from the shaft to serve as a storage place for tools and a refuge place for the men while blasting. It will sometimes happen that the shaft will not have to be cut through to the surface; the influx of water from the strata penetrated being used to make a downcast drift in one of the compartments, the other becomes an upcast, and by suitable connections below with the air drift and workings a satisfactory ventilation is obtained. The cost of air shafting varies from $1 75 to $4 a foot. It is usually done by contract, tools, timbers, blacksmithing, and carman being furnished. Air drifts are either the working drifts and gangways, connected and arranged with doors to keep the air current as desired, or a specially constructed drift in unbroken ground with connections made as needed to the workings. In the latter case it is made small, without timbering if possible, and costs from $1 75 to $4 a foot. As compared with the higher figures

of cost for shafting and drifts, a blower and air pipe is more economical. In this connection it is to be noticed that compressed air is undesirable and unsuitable for ventilation.

The main tunnel, drifts, and gangways all have track laid in them and switches of various patterns are placed at all junctions and intersections. In the main tunnel the track is laid permanently; in the drifts and gangways it is removed as soon as the ground is worked out, and relaid elsewhere. The gauge is twenty inches usually, sometimes eighteen or twenty-two. Two styles of rail are used, the light steel T rail weighing from sixteen to thirty pounds to the yard, or a strap iron rail. The former is laid and spiked on ballasted cross ties, the latter spiked on wooden stringers, the stringers being attached to mortised ties by wedges driven toward the face of the tunnel or drift. The T rail, though of greater first cost, is more economical, being practically indestructible and very smooth running. Strap iron wears rapidly and unless very carefully laid, is rough at joints. Convenience of taking up and relaying is also somewhat in favor of the T rail. The cost of steel T rails, weighing thirty pounds to the yard, laid, is from 60 to 75 cents per foot of tunnel. Strap rail costs laid from 25 cents to 40 cents a foot, dependent on the weight of the iron. Switches are made where permanent, in the usual railroad form. At temporary intersections and junctions in the mine, there are temporary turntables with or without track, or smooth sheet iron plates on which the car itself is turned to the desired change of direction.

In nothing about the equipment of a drift mine is there so much diversity of opinion and practice as in the cars. These vary in dimensions, shape, material, discharging gear, and capacity. In a mine where a large amount of gravel is handled daily, all these particulars require attention, and the best form of car must be used; in smaller mines the matter is not of as much consequence. The guiding consideration is ultimately the economy of working. Cars constructed of iron will have the largest capacity in proportion to their weight, also the longest life and least expense for repairs. Their first cost is but little more than for wooden cars, so they are the most economical under all conditions. The use of dumping chairs or other similar gear for discharging cars at the dump, permits them to be made without any form of gate and its attendant movable parts so liable to get out of order. Probably the most improved form is that in use at the Red Point Mine, which has the front discharging end set at an angle of 45 degrees with the bottom, so as to empty in the dumping chair on that angle of turn from the lever. The capacity of the cars is regulated largely by the motive power employed. If pushed in and out by hand, one car at a time, they can advantageously be put up to two tons in capacity. If taken out in trains by horse power, a capacity of one ton is most convenient; by locomotive, up to two tons.

In most mines the cars are moved by hand, and for a small mine this is the least expensive power that can be used. In the Paragon Mine one carman, wages $2 50 a day, takes fifteen to sixteen carloads, two tons each, of gravel out per ten-hour shift, the length of the tunnel being over eight thousand feet. On return trips he takes in tools and timbers. The entire force of miners take in empty cars when they go in the mine to work, and bring out full ones as they return without any appreciable loss of time from their legitimate work. Horse power is used in many of the larger mines, the cars being brought out in trains, from five to ten cars in a train. In the Hidden Treasure Mine three horses and two drivers bring out an average of three hundred carloads of gravel daily from a tunnel over seven thousand feet long. In the mine a carman makes up the train of full cars

on a switch in the main tunnel ready for the driver; the driver brings the empty trains in, immediately unhooks his horse and fastens it behind the full train, runs the latter out of the mine to the dump under control of the brake alone, the horse following after at a trot, hooks on to the empty train, already prepared for him by the dump man, and returns to the mine without loss of time, to find another full train prepared for him. In the Red Point Mine the driver of the train in the main tunnel fills his cars from the chute in the upraise to the channel, takes them out, dumps them, and unmakes and makes his own trains. With a larger output this would be changed more to the practice of the division of labor in the Hidden Treasure Mine.

In two mines in this State—the Bald Mountain and the Turkey Hill—small, specially constructed, and very powerful locomotives have been used to take trains of cars in and out of the long tunnels of these mines, in both instances working satisfactorily and economically. The fuel used was anthracite coal, which delivered at the mine cost $50 a ton. This was smokeless, and the stacks were fitted with cinder arresters to avoid the danger of setting the tunnel timbering on fire. It will be noticed that where horse or steam power was used it was only in the main tunnels, the cars being moved in the drifts and gangways by hand. In mines where the main tunnel is in the bedrock, the cars used in it do not go into the mine proper, but only to the upraises connecting the main tunnel and the working drifts above. In these latter and the breasts another set of cars are used, moved by hand, which discharge into compartments in the upraises called chutes. These will hold several carloads of gravel, from which the cars of the main tunnel are filled by opening a gate at the lower end. Where the gravel has to be raised in the mine after the cars are first loaded, it is preferable to have it done up a slope through which the full car can be drawn, thus avoiding the handling of the gravel over, which adds rapidly to the cost of mining, and is as undesirable as pumping underground by steam pumps. In the Mayflower Mine the gravel had to be handled seven times before it reached the surface. The heavy cost of this and of pumping forced the abandonment of the Mayflower shaft, and warranted, to replace it, the construction of a tunnel 6,000 feet long, at a cost of $100,000. The cost of moving gravel out of a drift mine by hand varies from 5 cents to 20 cents a carload; by horse power (allowing keep of horse, 80 cents a day wages at $3), is from 3½ cents to 8 cents, dependent on distance.

The treatment of the gravel to obtain the gold is either by washing it from the dump through the sluices, or, should it be cemented, crushing it in the stamp batteries of a quartz mill. The washing plant has already been described. In small mines where not over one hundred carloads a day are taken out, the washing is done by the Superintendent or the foreman. In larger mines there are one or two men steadily employed at the washing and cleaning up of the sluices. The latter is done in sections, the upper boxes certainly once or twice a day in some mines—those further away from the dump less frequently. The tailings are not allowed to escape at once, but are caught in brush and log dams, and allowed to accumulate and slack for several months, when they are rewashed. The common practice in the mines is to sell them outright for a lump sum to Chinese or others, who take the chances on getting back their cost and the expense of washing. The cost of washing per carload is from 1½ cents (with large amounts of gravel and free water) to 3 cents. In milling gravel the batteries are best fed by automatic machine feeders. Hand labor is necessary, however, to separate large cobbles, which can be partially screened

out by a grizzly. The cost of milling gravel per ton in the Paragon Mine, with steam power mill, is $0 35 a ton. At the Dardanelles, the cost with steam power, five-stamp mill, is $0 33 a ton. With water power mill the cost of milling the same gravel (exclusive of the cost of the water) would be $0 20 a ton.

The specialized duties in which labor is employed in a drift mine, the ratios between the amount of labor in these several capacities, and its cost, are seldom exactly the same in any two mines. The figures for three mines are given here, and will furnish a fair basis from which to make estimates for projected work:

	Dardanelles.		Paragon.		Red Point.	
	No.	Wages per Day.	No.	Wages per Day.	No.	Wages per Day.
Foreman	1	$3 50	1	$3 50	1	....
Shift bosses	2	3 00	....	....	2	$3 50
Breasters, white	24	3 00	17	3 00	9	3 00
Breasters, Chinese	....	....	....	....	9	1 75
Tunnel men	....	....	2	3 00	2	....
Drift men, white	....	....	....	....	3	3 00
Carmen, inside, white	....	....	....	....	....	....
Carmen, inside, Chinese	....	....	....	....	6	1 50
Carmen, outside	1	3 00	1	2 50	....	....
Drivers	....	....	....	....	2	3 00
Blacksmith	1	3 00	1	3 00	1	3 50
Blacksmith helpers	....	....	....	....	1	3 00
Carpenters	....	....	....	....	3	4 00
Surface men, white	1	2 50	....	....	1	3 00
Surface men, Chinese	....	....	....	....	4	1 75
Engineers	2	3 50	1	3 50	2	3 50
Battery feeders	2	2 50	2	3 00	....	....
Totals	34	....	25	....	46	....

In the Dardanelles the full force possible is working in two shifts. The force can be doubled in the Paragon, the present force only working days. At the Red Point, with sufficient water for washing, a hundred additional men could be employed in breaking out ground already opened by drifts and gangways. The Hidden Treasure Mine employs from one hundred to one hundred and seventy-five men in all capacities, the larger proportion in breasting out gravel. In the Bald Mountain Mine as high as two hundred and fifty men have been employed at one time in all capacities. In the running expense of a drift mine, the cost of labor is by far the largest item, the proportion, as compared with all other expenses, being nearly uniform in all of the mines. For the Hidden Treasure Mine the ratio for four months of 1888, taken at random from the books, is: For wages, 78 per cent; all other expenses, 22 per cent. For the same mine for the eleven years from 1877 to 1887, inclusive, the ratio was 78 per cent, and other expenses 22 per cent.

The considerations that should govern the development of a drift mine and the most successful practical working of it, summarized from the preceding pages, are the following: The development or opening of the mine should be done in the manner that will make the subsequent mining of the ground—that is, the running expense per unit (carload or ton) of gravel—the cheapest. This means, drift mining ground not being uniform in gold yield, that the greatest amount and area of ground can then be mined at a profit over running expenses, and that more thorough pros-

pecting that is not dead work can be done. This points, not to the lowest possible construction account necessarily, but to that which will in the running expense of the opened mine make all the several items take their minimum value, and permit of the largest proportion of the total of all of them being expended in the actual mining or breaking out of the pay gravel. It is from this last consideration that the tunnel is the best form of opening, for through it can be reduced to their minimum value the several items of drainage, ventilation, and moving of gravel to the surface.

The gold yield of the gravel is estimated at so much per carload, but the differences in capacity of the cars used in different mines makes direct comparison impossible. For convenience it is desirable to adopt as a unit the ton of two thousand pounds. The minimum limit of yield which it will pay to mine, or rather the minimum of the running expense of mining (for it will pay to mine gravel which will just meet this expense, as increasing the probability of discovery of richer ground), has a wide range as between the different mines. Probably the lowest paying gravel and the cheapest mining is that of the Hidden Treasure Mine. From February 27, 1888, to June 30, 1888—one hundred and eight working days—the figures are:

	Per Load, One Ton.	Total.
Gold yield	$1.2347	$39,821 53
Wages	.7202	23,528 00
Contracts	.1077	3,464 78
Expense, material, etc.	.0957	3,086 94
Total expense	$0.9236	$30,079 72
Profit	.3111	9,741 81

Number of days' labor, 11,164.50. Number carloads gravel, 32,252.

For the eleven years, 1877 to 1887, inclusive:

Receipts.

Gold yield	$879,523 27
Receipts from other sources	19,176 16
Total	$898,699 43

Expenditures.

Wages	$490,297 64
All other expenses	137,064 35
Dividends	268,092 00

The cost per carload ($.9236) is exceptionally low, as under ordinarily favorable conditions $1 50 to $1 75 a carload is as low a figure as can be anticipated, and in most of the mines the cost is from $2 to $3.

The future of drift mining in the State is decidedly promising. The better knowledge of the character and situation of the auriferous buried channels, and the more systematic methods of exploration and mining now employed, have taken away much of the uncertainty which has made so many failures among the earlier drift mining operations. As compared with hydraulic and quartz mines, fully as many single drift mines have made gross yields running above $1,000,000, and as many to-day are in the course of development to this point of productiveness.

LITHOLOGY OF WALL ROCKS.

By Melville Attwood, E.M., Assistant in the Field.

I respectfully present herewith the results of my examination and determination of the rocks forming the sides of the well known and important auriferous fissures in the State.

I now also submit the conclusion I have arrived at respecting the true condition of the gold met with in the various forms of gangues, or matrices, found in what are termed lodes, or veins; and I must add that though I have made the investigation a special study for the past twenty years, I now, more than ever, fully realize both its difficulties and its importance.

INTRODUCTION.

The igneous rocks forming the walls of our richest gold mines vary much in composition.

The highly crystalline portions, however, appear to have been formed when the liquid mass was cooled down with extreme slowness. There has taken place a great alteration in the constituent minerals of these rocks, owing to the action of chemical forces, which are everywhere at work within the earth's crust, and which have in many cases so changed the appearance of these rocks, that specimens taken at different points from the same wall, or dike, present a different appearance, and their identity may easily escape recognition.

A very interesting paper was read before the London Geological Society in 1883 by J. J. H. Teall, Esq.: "Petrological Notes on some of the North of England Dikes," wherein he states that "the Cleveland cockfields and Armathwaite dike varies very much in thickness, both in a vertical and a horizontal direction; that it frequently dies out before reaching the surface, and that it is liable to lateral shifts, and that absence of continuity in the outcrop is thus seen to be *no* proof of a want of continuity under ground."

The subject was treated in an exhaustive manner by the author, and will, if read carefully, throw a good deal of light on the wall rocks and dikes of California.

In 1868, accompanied by Arthur Dean, I examined the Clogan Mines in North Wales, Great Britian, of which mines Mr. Dean was the manager and one of the principal owners. In a conversation with him respecting the productive and unproductive parts of the Clogan lodes, he (as the best answer to my questions) made me a rough cross and longitudinal section of those lodes, which I have had mounted, and being, as I consider, a valuable guide for the gold miners, have presented it to the Bureau, where it can be seen by any one who feels interested in the matter.

The cross sections show the lodes occupying portions of fissures made by the dislocation or displacement of the different strata or rock beds. The formation is the lower silurian and cambrian grits, and consists of beds of slate with cleavage, grits, and *intrusive* beds of diabase. The underlie of the lodes are about 10 degrees and the dip of the beds of slate, etc.,

about 33 degrees; the "throw" or vertical displacement from eight to nine feet.

In speaking of these fissures they are invariably, when not occupied by auriferous lodes or vein matter, filled with materials derived from the ruins of the adjacent rocks, at the time of the fracture or dislocation, or afterwards brought into them.

It will be seen by the cross section, on which the rich portions of the lodes are marked, that their most productive parts were those having for their walls the intrusive diabase, and that, when the walls were either of slate or grit, the lodes were poor.

The milling at Clogan was very well conducted and the loss in treatment, considering the character of the veinstone, comparatively small—the concentrators were an improved form of the Rittinger.

I first visited the North Wales gold mines in 1849 and examined the Cwmbeisian mines for Mr. James Harvey.

In the great "lead measures of the north of England" the only place where gold was met with, though most of the lodes produced very large quantities of silver, was a small vein in the Diabase Whin Dike, Tynehead Fell, but it occurred in such small quantities that Mr. Hugh Lee Pattinson (the inventor of the Pattinson process), I believe in 1846, gave me some pieces of the veinstone to pan out for gold, remarking at the same time that it would take one guinea to get a sovereign's worth of gold if the vein were worked. It showed a little gold in panning out.

A paper was read before the London Geological Society in 1878, by Richard Daintree, Esq., "Notes on Certain Modes of Occurrence of Gold in Australia." Mr. Daintree said as follows:

"In a paper read before the Geological Society in April, 1872, 'The Geology of Queensland,' it was pointed out that a large area of devonian rocks existed in that colony, and that numbers of gold fields had been opened on such areas. Attention, however, was drawn to the fact that the auriferous tracts were entirely confined to such of those devonian districts as were found to be penetrated by certain *plutonic rocks*, principally diorites.

"In these diorites, and at and near their intersection with the devonian strata, auriferous quartz, calcspar, and pyritous reefs had been examined, and were proved to be rich in gold, whilst the *extension* of such veins at any considerable distance from the intrusive rocks was found to be barren.

"Instances were also adduced to show that the pyrites sporadically distributed through the diorites were occasionally decidedly auriferous, and by their decomposition and degradation had yielded alluvial drifts containing gold in paying quantities to work.

"Mr. Daintree then remarked that 'since this was written I learn from Mr. C. Wilkinson, the Government Geologist, of New South Wales, that the same facts hold good for those New South Wales gold fields which lie in devonian or upper silurian areas; and Mr. C. Ulrich, the talented Curator of the Technological Museum in Melbourne, in his catalogue of the rocks in that museum, gives details which prove beyond doubt that the upper silurians of Victoria owe their auriferous character to the same cause.

"He describes the diorites as occurring in Victoria mostly as dikes, varying in thickness from a few to several hundred feet, traversing upper silurian rocks, and presenting nearly all the ordinary varieties of texture and mineral composition.

"They are nearly always impregnated with auriferous pyrites, and traversed by or associated on one or both walls with auriferous quartz veins,

and by far the greater quantity of the quartz gold furnished by the gold fields occupied by upper silurian rocks is derived from such dikes of diorites.

"In support of these statements Mr. Ulrich especially notices the dike of Cohn's Reef (which, he says, is perhaps the richest one in the colony), and some specimens from which represent the variety 'diorite aphanite,' and the dike of the Albion Mining Company, at Crossover Creek, in North Gippsland, which is interesting on account of its highly micaceous character and its influence upon the gold-bearing character of the reefs which traverse it at right angles to its strike; and which, poor in upper silurian strata on each side of it, become richly auriferous throughout the width of the dike (about ninety feet).

"The practical value of these facts is great, as it narrows the search of the prospector for gold in the devonian and upper silurian areas of the Australian Alps, to the portions penetrated by certain *intrusive* plutonic rocks, or at all events primarily and especially in such areas."

Thus I think I have conclusively proved the theory which it has been the object of these quotations to establish, namely, that the term "auriferous slates" is a misnomer, so far as it implies that the gold itself is derived from the metamorphic slate, and that the geologists of other countries are agreed that gold is only to be found in connection with eruptive rocks, or in deposits derived from them.

THE SOURCE OR ORIGIN OF GOLD FOUND IN LODES, VEINS, OR DEPOSITS.

For nearly half a century I have been more or less practically engaged in gold mining and milling, and my researches during that time in the different mines I have had the management of, and in those I have examined in different parts of the world, have led me to conclude that the presence of gold in fissures or deposits is nearly always in connection with intrusive or eruptive rocks, and that the gold has been carried up in direct consequence of and in conjuction with the outburst of distinct plutonic and volcanic rocks.

I am also of the opinion that gold is not of itself characteristic of any sedimentary formation, and that when found in such beds it was the fragmentary debris of some auriferous eruptive matter of a previous age.

I believe it is generally admitted by mining geologists that auriferous veins only occupy limited portions of preëxisting fissures or fractures on the earth's surface, and that these fissures have been made by intrusive or eruptive rocks, or by the contact of two different formations, and, in some cases, by unequal elevating or subsident forces, which are always attended by alteration of level in different parts of the same formation.

The gold, and also the gangue or matrices accompanying it, came, I believe, from the interior of the earth, either in a state of vapor or solution, the gold being precipitated from the solution in a metallic state, and the matrices, differently mineralized, forming deposits in every respect different from the inclosing rocks.

Mr. Lauer, in a communication to the Academy of Sciences, of France, "On the Origin and Distribution of Gold in California in 1863," mentions having found metallic gold in deposits, evidently derived from some hot springs west of Steamboat Springs.

Crystallized gold has also been found in the siliceous sinter with cinnabar in Lake and Colusa Counties—specimens of which I sent to I. Arthur Phillips, F.R.S., mention of which is made in a paper read by him before the Geological Society of London, "A Contribution to the History of Mineral Veins."

Gold has also been found in stalactites in an Australian mine.

The occurrences of auriferous pyrites in some diorite and diabase wall rocks at a distance from the "casing," is a very interesting study, and requires a careful microscopical investigation to solve the question, "When was it deposited?"

The different forms of pyritic matter carrying gold mechanically mixed and inclosed in them, will be found amongst the collection at the Bureau.

The arsenical form carries the most gold, and the cubical form generally the least.

The gold in pyrites is mechanically mixed and disseminated in them in an extremely fine condition, some of the grains being smaller and lighter than sea beach gold.

The gold in some of the small specks of ferruginous matter met with in quartz veinstone, if examined with a microscope, will generally be seen to be beautifully crystallized.

The largest pocket of gold that I have seen in California was one I found on North Gold Hill, nearly in the town of Grass Valley, in 1859. I took out many thousand dollars' worth of gold, all in a leaf-shape form, with beautiful crystals of quartz, and they were all imbedded in a decomposed ferruginous matter.

It is now generally admitted that all gold, except that chemically combined with tellurium, exists in a metallic state—that embryonic or immatured gold does not exist in pyritous minerals, and it will be time enough to use the term "gold ores" when they are found. I think the day is come when the man who talks about *gold ores* will be listened to with a smile, and not argued with.

AURIFEROUS LODES OR DEPOSITS OF CALIFORNIA AND THEIR INCLOSING ROCKS.

Two of the principal auriferous dikes in California are the Amador diabase dike, Amador County, and the Eureka, Idaho, and Maryland diabase dyke, in Nevada County.

The two richest and most continuously producing mines as yet met with in California have been found in connection with those two dikes. The Eureka, Idaho, and Maryland dike forming the hanging-walls of those mines, which may be classed as one, and the Amador dike which forms the hanging-wall of the Keystone Mine.

Attached to this report is a plan of the "Great Amador Quartz Vein," showing the position of the different claims and the course of the dike. It was surveyed by Mr. I. Brown, and obtained for the Bureau through the kindness of the Surveyor-General.

J. M. Macdonald, Esq., President of the Keystone Company, kindly furnished me with a surface plan of the Keystone Mine, showing the course and width of the dike and the adjoining claims. He also gave me plans of the different levels, which show much better than I can describe the way in which the auriferous quartz and pyritic matter occurs. They are to be seen at the library of the Bureau.

At the points where the different planes in the bedding of the slates strike the vein, it is either enriched or impoverished, or, often, cut out. It is useful to remark that the planes of bedding are generally at right angles to the dip of the vein.

The gross receipts of the Keystone Mine are $8,400,000, and the dividends paid $3,700,000.

The intrusion of dike matter between the cleavage of the slate, and the influence of that, and the planes of stratification or bedding upon the productiveness of the deposits is a very interesting study.

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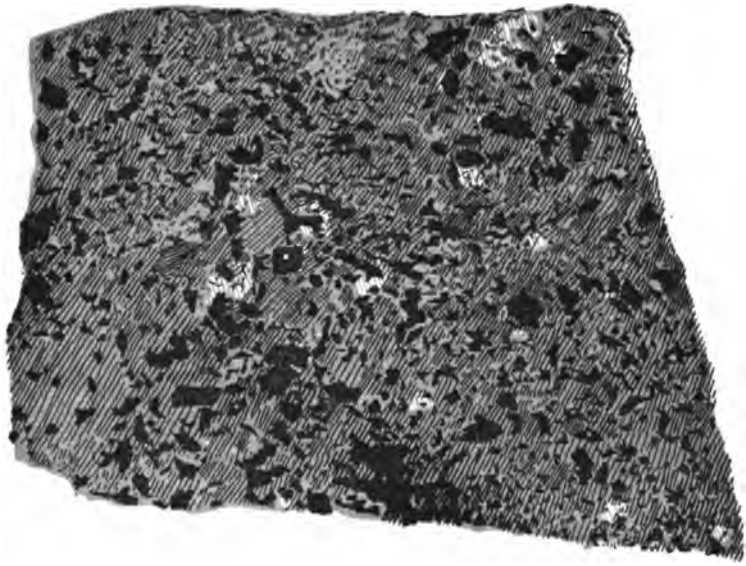
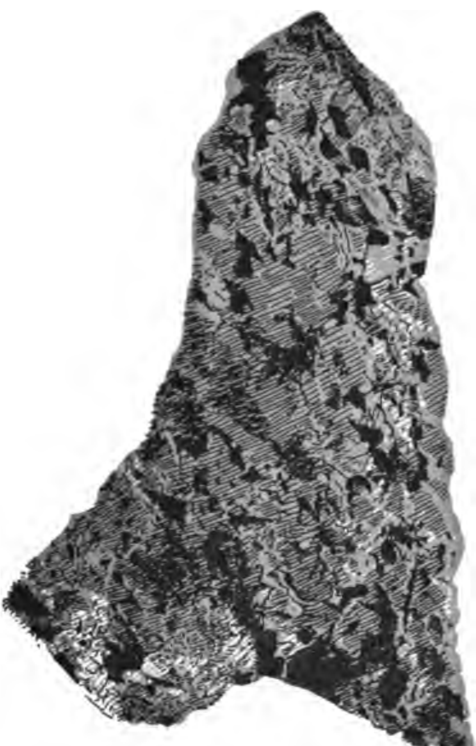
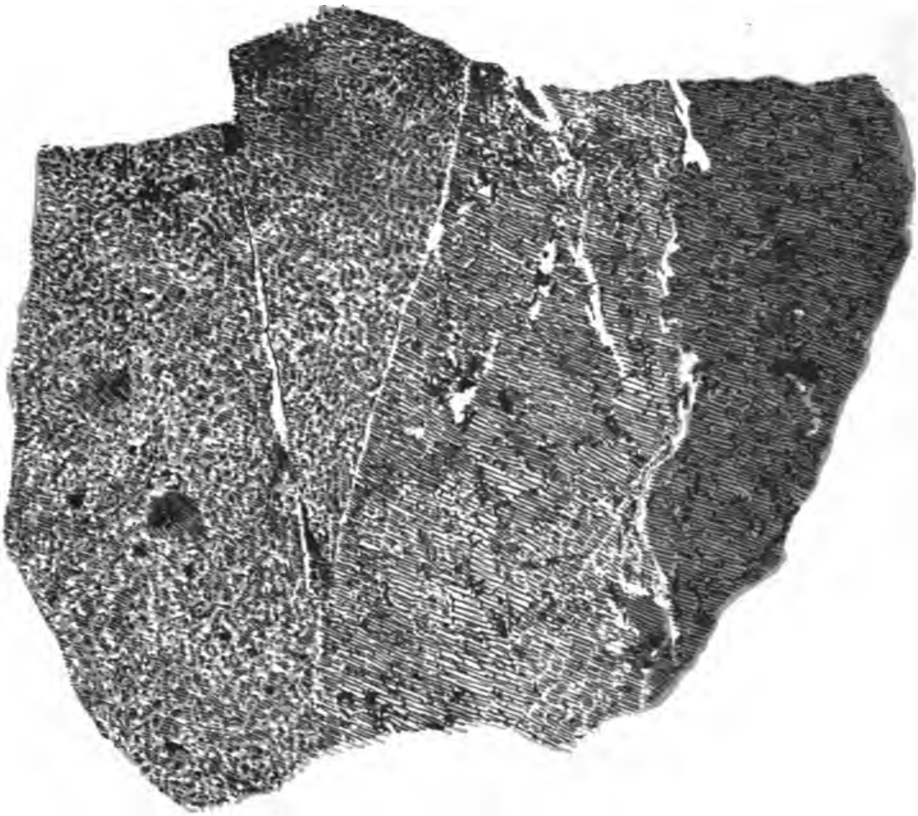


No. 1. Keystone Dyke.



No. 3. Altered Gabbro.

No. 4. Footwall of the Idaho, 1,500-foot level.



No. 2. Hanging Wall, Eureka Mine, Where the Lode Was Very Rich.

No. 5. Horse in Eureka Lode, 400-foot Level.

No. 6. Hanging Wall of Providence Mine.

The course of the Amador dike and the strike of the cleavage of the slate are nearly the same, running in one given direction of the compass over nearly the whole of the ground I have examined.

In the library of the Bureau will also be found a plan of the surface location and a longitudinal section of all the underground workings from the Oneida to the Lincoln Mine. It was surveyed under my direction many years ago (1872), but shows the line or zone of productiveness of the mines at that time.

At Quail Hill, Calaveras County, and near Lincoln, Placer County, where copper ore was met with, in the slate rock, intruded small dikes are found sometimes between the cleavage of the slates; and on the sides of these dikes, a few inches of a ferruginuous matter is occasionally met with rich in gold.

The Amador dike, like those in the north of England and elsewhere, may be traced for a long distance, and on its sides are found the auriferous deposits called the "mother lode."

To the west and east of the dike is argillaceous slate, forming the foot-wall of most of the so called lodes or veins.

Branch dikes occur at different points, but the rock in them has been very much altered, as at the Zeile and other mines.

The course of such branches continues the same as the strike of the cleavage in the slates, though the dip of the cleavage is not so regular.

I have collected and roughly cut a very large number of sections from this dike; but, finding the rocks above the keystone to be less altered than at any other point, I selected specimens from them, had slices made for macroscopical examination and sections cut for microscopical determination. No. 1 represents one of the slices made for macroscopical examination, and I think it shows the character of the rock well, and will be better understood by my fellow miners than any plate from microscopical sections.

I have selected two microscopic sections of the rock taken from the Keystone Mine—one cut exceedingly thin and the other only sufficiently so—to show distinctly the different colors in the rock. They are both in the collection at the Bureau.

The results of the examination of a specimen of rock from the one thousand-foot level of the Keystone Mine are as follows: A basic igneous rock of a dark, greenish color; specific gravity, 2,800; contained silica, between 44 and 45 per cent.

Under the microscope the following minerals were found: Oligoclase, albite, anorthite, chlorite, pyroxene (augite), labradorite, and as accessories, magnetite and pyrite.

The mineral is rather coarse-grained and somewhat porphyritic, as crystals of oligoclase were observed in the section imbedded in a compact matrix. The mineral may be classified as a diabase (somewhat porphyritic).

The Eureka, Idaho, and Maryland diabase dike, in Nevada County, is first seen a short distance west of the Eureka claim. It can then be traced eastward through the Eureka, Idaho, and Maryland ground. The Idaho Company has from the nine hundred-foot level driven a crosscut south for a distance, I believe, of some six hundred feet into that dike, but what really is its width it is difficult to say. It forms, however, the hanging-wall of the three claims; their foot-walls being an altered gabbro, called serpentine. No. 2 represents a slice cut from a hand specimen taken from the hanging-wall of the Eureka Mine at the four hundred-foot level, where the lode was rich; No. 3 is the altered gabbro some distance north of the dike; No. 4 the foot-wall of the Idaho at the one thousand five hundred-foot level; No. 5

the *horse* met with in the Eureka lode at the four hundred-foot level, and one hundred feet east of the shaft; No. 6, end view of the lode in the east and west drifts of the Eureka Mine at the three hundred-foot level, showing the horse in the lode.

In my sketch map of the Grass Valley District, the positions of these claims are shown, and in No. 7 a rough plan and longitudinal section of them, showing the rich shoot of veinstone in the three claims.

I have carefully examined macroscopically and microscopically endless specimens from the hanging-walls at the different levels of the Eureka and Idaho Mines, and, though they differ greatly, yet the results are such as to leave no doubt in my own mind that the rock is diabase; so I selected three specimens, being about as fair an average as I could collect, and the following is the result:

No. 1.—Hanging-wall, Idaho, one thousand five hundred-foot level. A dark-green mineral, showing under the microscope, oligoclase, labradorite (soda lime feldspar), anorthite (lime soda feldspar), and chlorite, magnetite, and pyrite with calcite were observed as accessories. Specific gravity, 2.8 Basic. The rock may once have been a dolerite, but it now should be classed as a diabase.

No. 2.—Hanging-wall, Eureka Mine, six hundred-foot level. A similar rock to No. 1, presenting a dark-green appearance under the ordinary lens, and under the microscope showing oligoclase, labradorite, anorthite, and chlorite, magnetite, pyrite, chalcopyrite, and calcite as accessories. The crystalline forms are not as distinctly developed as in No. 1, and the rock also contains an excess of pyrite, as if it had been obtained from near a metalliferous deposit, and it is not unlikely that a careful analysis would show the presence of gold. Specific gravity, 3.0. The rock may be called a diabase.

No. 3.—Hanging-wall of the Eureka, four hundred-foot level. Dark-green rock. Specific gravity, 2.9. Showing, under the microscope, oligoclase, labradorite, anorthite, and chlorite; magnetite as accessory. It resembles No. 2, but does not contain so much pyrite. It may be classed as a diabase.

This rich shoot of auriferous veinstone, varying in vertical width from four to five hundred feet, follows the strike of the fissure eastward, with a slope or "hade" of about 20 degrees from the horizontal. It has now been worked for a distance from the Eureka croppings (as nearly as I could ascertain without a survey) of four thousand feet—the horizontal width of the quartz or vein matter varies from one to many feet. The gold extracted from the croppings and deep workings up to the present time foots up in the neighborhood of $16,000,000.

I have never read of or seen in all my travels a shoot of rich veinstone like it, and, as all information respecting it will be valuable to prospectors, I have devoted a great deal of time to examining the character and condition of its inclosing rocks, and their general macroscopical characters, which I have tried to show by photographs taken from polished slices of them.

Many years ago (1859, I think) I treated at the Gold Hill Mill a considerable quantity of the veinstone from the Eureka croppings for the late Mr. B. L. Lamarquet. It averaged about $8 per ton, which in those days was barely sufficient to cover expenses, showing that the pay shoot above the water level or line of decomposition was poor.

Late developments show that the shoot of veinstone is flattening and rising nearer the surface, also increasing in size and richness. The gross

yield of the Eureka was $5,700,000, out of which $3,000,000 were paid in dividends.

From the Idaho the gross yield was $10,000,000, and dividends above $5,000,000. So far no rich pay has been found in the fissures except in shoots.

I think the richest croppings above the water line met with and treated in quantity in the Grass Valley District was from the Allison Ranch Mine in 1855. Twenty-one tons milled at the Gold Hill Mill yielded at the rate of $370 per ton.

I have noticed in east and west fissures, with inclosing rocks similar to the Idaho, and dipping to the south, that the auriferous shoots with rich pay in them, though the shoots vary in vertical width, generally slope on the course of the fissure to the east, and, on the contrary, when the dip is to the north the slope of the shoot will be to the west. The course of the fissure in the North Star is east and west and dips in the old working, averaging about 22 degrees to the north.

The Gold Hill and Massachusetts Hill fissure's general course is north and south and it dips to the east.

This fissure follows the contour of the hills, and the dip varies very much in accordance with the slope of the ground at the surface. It can be traced from the head of Rhode Island Ravine over Gold Hill and Scadden Flat to Massachusetts Hill. I had plans of the underground workings showing the different connections, but I cannot at present find them; but the fissure has been drifted in from the old Gold Hill tunnel, Rhode Island Ravine, along the east side of Gold Hill under Mr. Watt's house, into Scadden Flat, and from there into Massachusetts Hill.

I think, at the lowest estimate, between four and five millions have been taken out of this fissure. The shoots of rich pay were much more regular on Massachusetts Hill than on Gold Hill, where it was found mostly in patches or pockets.

From the New York Hill mines large quantities of gold have been extracted.

The course of the Omaha and Lone Jack fissure is north and south, dipping to the west.

The Allison Ranch fissure is north and south, dipping to the west.

The Norambague fissure runs north and south, and in the old workings dips east at an angle of 17 degrees.

The Empire or Ophir Mine fissure courses north and south, having a westerly dip. The mine has been worked since 1851, and from, I think, 1856 to 1864 the Empire Company took out $1,000,000.

The inclosing rocks of the Crown Point, New Eureka, Brunswick, etc., I have not yet determined.

I mined and milled large quantities of rock from Osborne Hill from 1854 to 1860, and am of opinion that with the present facilities for working, that is, water power, cheap labor, and supplies, these mines may be opened again to advantage.

The placer gold in Wolf Creek and its tributary was derived, no doubt, from the decomposition of the croppings of the different auriferous veins; the Allison Ranch lode, for instance. Its rich croppings were in the bed of Wolf Creek.

The richness of the gravel and coarseness of the grains of gold increase very perceptibly as we ascend Wolf Creek from Bear River.

In the Nevada City District the principal lodes are the Providence, Merrifield, Wyoming, Nevada City, Mount Auburn, etc. These lodes occupy fissures or spaces left between two different formations of rocks, and are

called "contact veins;" the hanging-wall, or the upper sides of the fissure, being "syenitic granite."

The foot-wall, or lower side of the fissure, being a highly "metamorphic slate;" which, as a rule, is now distinguished as the results of "contact metamorphism." This term means the alteration produced upon sedimentary rocks by the intrusion into them of igneous masses. The general course of these fissures is northwest and southeast, with an easterly dip averaging somewhere about 35 degrees from the horizontal eastward.

The rich auriferous veinstone occurs in large deposits, chimneys, or pipes, and isolated patches. The rich deposits are best seen in the Providence Mine.

At the Bureau library, in a portfolio of the Nevada County mines, there is a plan and cross section of the largest deposit met with in that mine. Also a longitudinal and cross section of the Nevada City Mine shows five chimneys or vertical shoots of veinstone.

At the Mount Auburn Mine the rich veinstone was in isolated patches.

The character and condition of the rocks inclosing auriferous matter, in which the pay or richer parts occur in shoots and deposits.

The Eureka, Idaho, and Maryland vein has diabase for the hanging, and an altered gabbro for the foot-wall.

Amador quartz vein—the hanging-wall is generally a true diabase and the foot-wall a metamorphic slate, with distinct planes of bedding and cleavage.

The Providence and Nevada City veins have syenitic granite for the hanging, and a highly metamorphic slate for the foot-wall; the rich pay is found in chimneys, pipes, etc.

The Indian Valley vein, Plumas County, has a syenitic granite for each wall, and the rich pay occurs in chimneys or pipes.

The granitic rocks are generally those in which chimneys or pipes are met with, so far as I have investigated the matter.

AURIFEROUS VEINSTONE.

The gangues, or foreign matter, with which the gold is associated, and mode of treatment in milling the same recommended:

First—Gold in jacotinga, a micaceous iron ore; hardness, 5; specific gravity, 4.3; streak reddish brown, and sometimes attractable by the magnet; not yet found in California. In Brazil it forms the gangue of some of the richest auriferous lodes, the country rock being itabiryte, a schist resembling micaschist. At the Gongo Soco Mine, Brazil, large quantities of gold were washed out of the jacotinga, with bateas by African girls, after it had been pounded in large mortars. The colored men could not be trusted. When the lode was rich one hundred and twenty pounds per day was obtained in that way. The poorer portions were passed through the stamps, and the gold saved by "straking."*

Second—"Talcose slate" quartz and small quantities of pyritic matter, recommend "straking" with blankets and amalgamated plates suspended and with end percussion; steel wire screens with net aperture one thirtieth of an inch, and the amalgamation of the concentrate in pans.

Third—Quartz with less than 4 per cent of pyritic matter, recommend mercury in mortars; amalgamated plates with small falls on them, sus-

*"Straking."—The Cornish term for concentration on rawhides, blankets, baise, and coarse canvas.

pended and with end percussion; also amalgamated plates over the revolving rubber concentrators.

Fourth—Quartz with less than 3 per cent of galena or zinc blende, treatment as No. 3.

Fifth—Quartz with large proportion of gossan or ferruginous matter—same as No. 2.

Sixth—Quartz with pyritic matter and tellurium, as petrite, generally occurs in small pockets. It is best to assort and separate before stamping and to dispose of it to be smelted; but when it is disseminated in the veinstone so that it will not admit of assorting, then roast the ore in heaps and treat the roasted ore as No. 2, using screens one fiftieth of an inch net aperture.

Seventh—Quartz with more than 4 per cent of pyritic matter and less than 10 per cent, treatment same as No. 2.

Eighth—Quartz with more than 10 per cent of pyritic matter—straking and amalgamation of the concentrates in pans or barrels when too poor for chlorination. On the amalgamated plates where there is a fall or drop, dress with a small quantity of amalgam of cadmium. It will save a good deal of fine gold.

The shoes and dies for the stamps should be made of the best forged steel, and the face or diameter of the shoes never less than nine inches; they will do a much larger amount of duty and last much longer than any cast steel. Steel wire screens are better than any other, having nearly three times the number of holes to the square inch that any punched screens have, and if corrugated, much stronger.

BLANKET SYSTEM.

The blanket trays should be eighteen inches wide and five feet long, with distributers on the head of each tray to regulate the flow of the pulp, and also with a small board across the foot of it so that the pulp, when it has left the distributers, will strike against it and fall on the blanket at about right angles to the flow; the blankets need not be longer than three feet. There should be three five-foot trays, one under the other, placed lengthwise, and three sets of each—or nine trays altogether for every five stamps. They should all be fixed on a frame, and so arranged that by using a small lever the angles of inclination can be altered to suit the character of the pulp being treated.

The head blanket, on which nearly all the gold will be collected, should be washed in a separate vat, and from there passed through one of my amalgamators, the tailings being allowed to flow into the pan where the second and third blanket sand is being treated.

It is usual to incline the head of the screens outwards at an angle of from 10 to 12 degrees from the vertical, but it would be much better to have the holes in the screens enlarged according to their height above the dies; say, in the lower part of the screen, for twelve inches, No. 30 steel wire, and, for the upper six inches, No. 24. I think such a system would secure the most perfect discharge for a given area of perforations. The horizontal distance of the screens from the dies, and the height of the bottom of the screen above the dies, will have to be regulated by the character of the veinstone treated.

The pulp from the different mortars should be allowed to flow all together and then distributed equally to the different belt concentrators. A much better average would then be obtained and a good deal of pyritic matter saved; as the pyritic matter is so unequally mixed in the vein-

stone and casings, I have frequently found, when sampling the tailings at different mills, that at times, when the pulp was flowing from one mortar to two belt concentrators, hardly any pyritic matter was passing over them; and a short time afterwards as much as 7 or 8 per cent.

In the Crown Point, Eureka, and Idaho lodes a dolomite gangue carrying gold is frequently met with. The following is the result of the analysis made of it by Messrs. Falkneau and Reese:

Analysis of Dolomite from the Sixteen Hundred-foot Level of the Idaho Mine, Grass Valley.

Carbonate of lime	$55\frac{5}{10}$ per cent.
Carbonate of magnesia	$40\frac{4}{100}$ per cent.
Iron and manganese	$4\frac{6}{100}$ per cent.
Silica	Trace.

The only, in my opinion, practical way of finding what really passes away, or is lost in the quartz mill tailings, is to use a properly constructed tye-buddle, and to hire the services of a good Cornish dresser who understands how to work it by packing and putting in the necessary stops. If the operation is well conducted the result will be fair samples of what are called the "slimes-middlings" and "heads."

"Distributers," or tongues for directing the course of the tailings, should be put in at the end of the tailings sluices, so that a fair average may be obtained, and the requisite proportions made to flow into the heads of the tye-buddles.

Any millman who can "van" with a shovel, or use the batea, realizes the great difference between an end percussion and an end shaking table, and the great superiority of the former over the latter in separating the heavier from the lighter mineral substances. Amalgamated plates on tables should, therefore, be suspended by two chains at the superior end and two rods at the lower end. To give the necessary percussion, there is required an upright spring, with a block of rubber fixed to about the middle of it, and a revolving shaft with cams. The cams should be so placed that they will move the top of the spring, and give it a backward movement, which movement, when released, will allow the rubber block to spring back and strike the end of the table with a hard or soft blow, which can be regulated according to what is required. A lever should be attached to the rods at the lower end of the table, so that the angle of it may be altered to suit the minerals passing over it.

A. Lietz & Co., of San Francisco, makes a small vest pocket micrometer, by which millmen may measure with tolerable accuracy the net apertures in the holes in their screens.

I found some mills where the rock treated was of so hard a character that the wear of slot screens was such that in a week's time the size of the holes or net aperture had nearly doubled.

MACROSCOPICAL EXAMINATION OF THE WALL ROCKS OF AURIFEROUS FISSURES.

The mere inspection of the outer surface of a rock, viewed as an opaque object, does not give such correct information as that obtained when the examination is made by transmitted light, and with the aid of the microscope; yet, if the examination is properly conducted, it will, I think, afford all the necessary information required by the miner to enable him roughly to distinguish the character of the inclosing rocks of most of our auriferous fissures, especially if the rocks should be of a coarse texture.

In the macroscopical investigation of rocks, those parts of the mineral constituents discernable by the naked eye, or by the aid of a common

magnifier, can be easily studied, with reference to crystalline form, cleavage, color, luster, streak, hardness, solubility in acids, magnetic properties, etc.

The specimen of rock selected for examination should have a good fresh surface of fracture, and be free from decomposition; size, about three by four inches across and one and one half inches through; with a trimming hammer, prepare the one and one half-inch face, or dress it as even as possible; then procure an iron plate, with a smooth face about ten inches square and one half inch thick, on which put emery powder No. 80 and water; rub the prepared face of the specimen upon it till it is smooth enough to polish.

This can be done by getting a piece of thick glass about same size as the iron plate, on which put fine emery and water, and again rub the specimen till you obtain a fine polish.

When polished heat the specimen on a stove so that you can barely handle it, and when in that condition rub Canada balsam over *one half* of the polished surface. When cold it will harden so that it can be handled without injury. A small fragment may be broken from the unpolished end to try its specific gravity, magnetic properties, and also for acid tests.

The following implements will be found sufficient for this simple mode of investigation:

First—A common magnifier mounted in horn, that being lighter than metal; it should have three powers, and be set in a spectacle frame with screws, so that the different powers can be easily changed.

Second—A small bar magnet and also a magnetic needle freely suspended or supported.

Third—A small unglazed porcelain streak plate.

Fourth—A bottle of hydrochloric acid with a fine glass rod attached to the stopper.

Fifth—A dressing hammer, with the head about three inches long; one end with a face half an inch square and the other chisel shaped.

Sixth—A pocket micrometer, same as made by A. Lietz.

Seventh—A piece of flat iron, ten inches square and one half inch thick.

Eighth—A piece of thick glass, ten inches square, and a few pounds of coarse and fine emery.

Ninth—Scale of hardness.

The best mode of determining the hardness, is to have the minerals forming the scale of hardness mounted, something like the writing diamond. Break, for instance, the corundum, topaz, etc., into small fragments, and after selecting those with fine, sharp points, proceed to mount them as follows:

Take a piece of brass wire three inches long by one eighth of an inch in diameter, and with a file make small notches on one end of the wire; then take "lapidary's cement," warm the end of the wire with a spirit-lamp or candle, and melt some of the cement on to it. By wetting the finger and rubbing the cement while warm, it can be molded into any shape desired. With a small pair of pliers take the small fragments of corundum, etc., heat one end of the corundum, and then place it into the cement. If this be properly done, it will answer just as well as if set in metal, with this advantage, that you can renew it at any time in a few moments.

In addition to the implements named, a small collection of the commoner types of foreign rocks should be procured, and prepared with polished sides, after the manner before described.

The specimens of igneous rocks should consist of granite, syenite, diorite, gabbro, diabase, dolerite, and basalt, and of small bottles with

fragments of the different feldspars, showing character and cleavage; orthoclase (potash feldspar); albite (soda), anorthite (lime), labradorite (lime soda); also, small pieces of hornblende and augite.

The triclinic feldspar may be distinguished from monoclinic, *e. g.*, oligoclase, or labradorite from orthoclase, by the presence of fine parallel striæ along the surface of certain of the cleavage planes. Hornblende crystals have generally a fibrous structure, by which they may often be recognized from augite crystals. In the following table by Professor Bonney, igneous rocks are classified, primarily, according to their mineralogical composition; and, secondarily, according to their intimate structure:

	Matrix Wholly Crystalline.	Matrix Semi-Crystalline.	Matrix Glassy.
1. Orthoclase feldspar.			
a. Quartziferous	Granite	Quartz-felsite	Quartz-trachyte.
b. Quartzless	Syenite	Orthoclase-felsite, minette	Sanidin-trachyte, pitchstone, and obsidian.
2. Plagioclase feldspar.			
a. Oligoclase, sometimes with quartz.	Diorite	Porphyrite	Andesite.
b. Labradorite, or an allied mineral or quartz	Gabbro, diabase, dolerite, basalt	Some basalts	Tachylite.

It will also be necessary to have a few specimens of metamorphic, crystalline schists, sedimentary and fragmental rocks.

With the small collection of the already named characteristic rocks for comparison, the rough determination of hand specimens of inclosing rocks may easily be arrived at.

The coating of Canada balsam shows the structure and crystalline character much better than the ordinarily polished surface, so that the tests for hardness, etc., should be applied only to the polished surface.

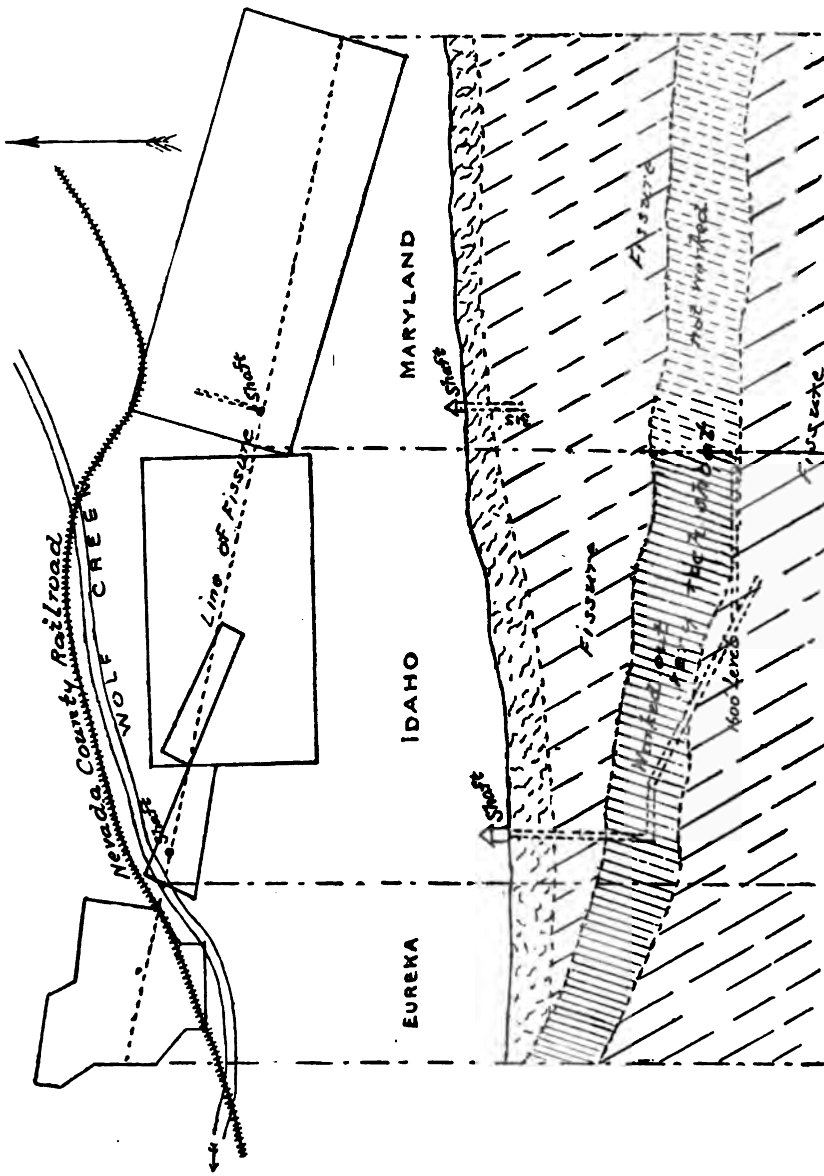
By having the lenses set in spectacle frames both hands are at liberty, one to hold the rock, the other to use the scale of hardness, or to apply the fine glass rod dipped in acid to try if any of the component parts of the specimen effervesce.

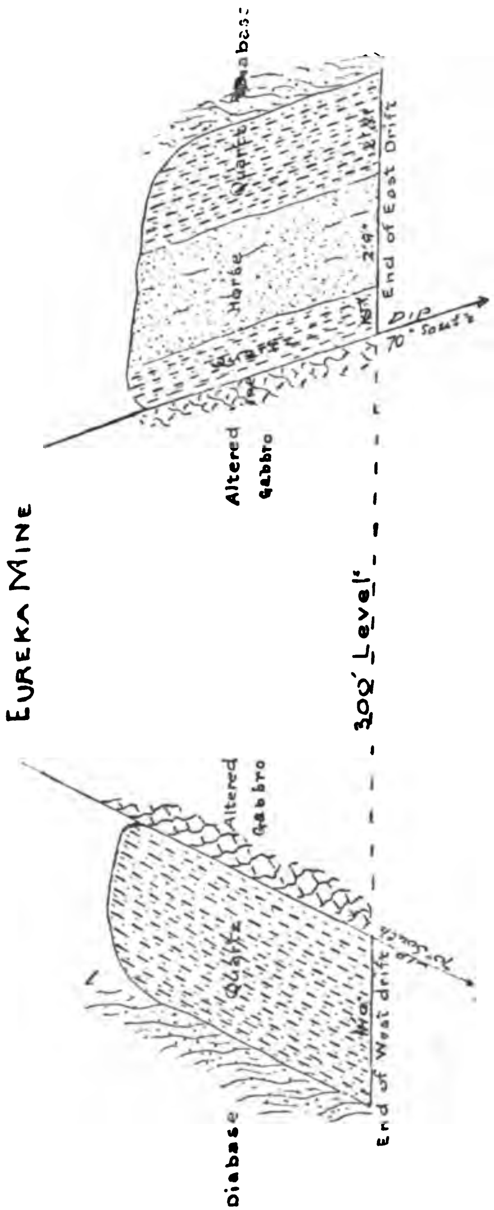
These tests for comparison can be applied to those types in the collection which resemble the one being tested.

The magnetic properties can be tested with a freely suspended magnetic needle, or by breaking a portion of the rock into small fragments, washing it in a batea, and then applying the bar magnet to the heavier particles.

The size of the crystals may be measured with a pocket micrometer.

I do not remember having seen or read of the macroscopic inspection of rocks being made by cutting large slices and polishing their faces, but whether it has been done before or not is not of much importance. One thing is certain that No. 2 specimen (photographed) taken from the hanging-wall against the richest part of the Eureka shoot, could not well be determined in any other way whether by chemical analysis or by microscopic sections. Therefore, the macroscopical examination of rocks is strongly to be recommended to all miners and prospectors as of the highest importance.


MARYLAND
IDAHO
EUREKA
WOLF CREEK
Nevada County Railroad
Line of Fissure
Shaft
Shaft
Shaft
Shaft
Fissure
Fissure
Fissure
Fissure
Not Worked


EUREKA MINE
300' Level
Diabase
Quartz
Horse
Quartz
Altered Gabbro
End of East Drift
Dip 70° South
Altered Gabbro
Quartz
Diabase
End of West drift

WATER WHEELS.

By F. F. Thomas, Assistant in the Field.

The machinery of many of the mills and hoisting works in this State is driven by water power; the mines and mills are so situated usually that large quantities of water with a low head are not available, consequently turbines cannot be employed, and the localities are few where a little water with a little head may be used for overshot wheels, but the construction of large mining canals, in a great many counties in the State, affording a high head of water, has led to the evolution of the pressure or tangential wheel, which owes its popularity to the adaptability of the wheel to the situation of the mines and mills, and to the high percentage of efficiency it develops, and its convenient size. The power utilized by the wheel depends on the weight of the column of water measured perpendicularly above the wheel, modified by certain variable losses. This pressure wheel is essentially the outgrowth of the necessities of the California gold mines. There are several varieties of these wheels, some with the buckets cast with the wheel, some with the buckets cast separately, differing in the shape of the bucket and mode of application of water to the wheel; the points of merit claimed by the different inventors are given in this article. The principle of these wheels is that the higher the head, within reasonable limits, other conditions being the same, the greater the power they can communicate, or the more machinery they can drive with the same amount of water. A tabulated statement of mills in operation driven by different kinds of wheels, under various pressures, with certain amounts of water, is herewith presented. The field covered by the statement is Amador, Calaveras, El Dorado, and Tuolumne Counties:

TABULAR STATEMENT.

Name of Mine or Mill.	Location.	Leffel Turbine	Overshot	Hurdy-Gurdy	Diameter, in Feet or Inches	Knight	Diameter, in Feet or Inches	Pelton	Diameter, in Feet or Inches	Donnelly	Diameter, in Feet or Inches	Head or Pressure, in Feet	Volume of Water, or Miner's Inches Required	Machinery Driven.
	Amador.													
Empire Mill	Plymouth									1	5 ft.	561	75	80 stamps, 750 pounds each.
Empire and Pacific Mine and Mill	Plymouth									5	4 ft. to 6 ft.	550 to 561		80 stamps, 1,000 pounds each.
		3				3	1 ft. to 6 ft.	7	3 ft. to 6 ft.	4	1 ft. to 3 ft.			48 Frue concentrators, rock breakers, hoisting gear, air compressors, sawmills, blowers, machine shop machinery, etc.
Loyal Lead	Drytown					1	8 ft.					260	26	10 stamps, 700 pounds each.
Gover	Drytown					1	5 ft.					150	130	20 stamps, 850 pounds each.
						1	3 ft.							11 Hendy concentrators, and rock breaker.
Bunker Hill	Amador					1	6 ft.					270	92	40 stamps, 850 pounds each.
						1	4 ft.							16 Frue concentrators, rock breaker.
Keystone*	Amador					1	6 ft.					254 to 266	165	40 stamps, 750 pounds each.
						3	3 ft. to 4 ft.							28 Hendy concentrators, rock breaker, sawmills, etc.
South Spring Hill	Amador					1	6 ft.					308	77	30 stamps, 750 pounds each; 10 Frue and 2 Triumph concentrators.
						1	3 ft.					270	15	Rock breaker.
						1	8 in.					265	†6	Dynamo.
						1	6 in.					270	½	Blower.
						1	6 in.					270	½	Grindstone.
						1	6 in.					‡125		Compressor.
North Star	Sutter Creek									1	6 ft.	200	6	Hoisting works.
Sutter Creek G. M.	Sutter Creek					1	4 ft. 6 in.					96	47 to 48	10 stamps, 850 pounds each.

						1	6 ft.					462	3 to 6	Hoisting works; 10 stamps, 750 pounds each.
						1	6 ft.					474	16	4 Frue concentrators.
Wildman	Sutter Creek									1	4 in.	462	½	Blower.
						1	30 in.					474	3	Rock breaker.
						1	12 in.					462	1	Dynamo.
						1	10 in.					462	½	Grindstone.
Lincoln	Sutter Creek					1	6 ft.					260	100	40 stamps, 850 pounds each.
Live Oak	Near Jackson									1	4 ft.	85	25	1 3-inch Cornish pump, and 2 stamps, 850 pounds each.
						2	6 ft.					181		South hoisting works.
								2	5 ft.			168		North hoisting works.
Kennedy	Near Jackson							1	5 ft.			230	245	40 850-pound stamps.
										2	12 in.	181		Blowers and grindstone.
								2	3 ft.			53		16 Frue concentrators, rock breakers, etc.
								1	6 ft.			145	190	40 750-pound stamps, 16 Frue concentrators, compressor, and blower.
Zeile	Near Jackson							1	6 ft.			100	40	Sawmill and framing machine.
								1	4 ft.					
										1	4 ft.	165	8	Shaft No. 1 hoisting works.
										1	12 in.	165		Blower for forge.
Amador Gold Mine	Near Jackson									1	4 ft.	165	17	Pump.
										1	12 in.	165	½	Blower, ventilation.
										1	4 ft.	165	8	Shaft No. 3 hoisting works.
								1	4 ft. 6 in.			165	35½	Compressor.
								1	6 ft.			401	90	60 stamps, 850 pounds each.
Amador Gold Mine	Near Jackson							1	2 ft. 6 in.			401	12	24 Frue vanners.
								1	4 ft. 6 in.			225	80	§3 No. 2 Gates rock breakers.
Amador Queen	Near Jackson					1	8 ft.					465	55	20 900-pound stamps.
						1	5½ ft.					465	12	Compressor.
Moore	Near Jackson					1	6 ft.					110	100	10 stamps, 850 pounds each.
Mammoth	Near Jackson					1	6 ft.					750	70	10 stamps, 750 pounds each.
Lambing Gravel	Near Ione					‖2	15 in.					68	400	100 to 500 miner's inches of water per day, raised 36 feet.
	Calaveras.									3	6 ft.			40 stamps, 850 pounds each.
								1	6 ft.					16 Frue vanners.
Ilex	Rich Gulch							1	5 ft.			500 to 700	200	Machinery of 2 hoisting works.
								1	3 ft.					Crushers, compressors, pumps, etc.
						1	8 ft.							Compressor, 20x24.

*Keystone Company also uses one Lepley tangential wheel, 4 feet 6 inches diameter, under 200-foot pressure. †This water used again in battery. ‡Water bought on contract per month. §Water reused. ‖Knight's turbine pattern.

TABULAR STATEMENT—Continued.

Name of Mine or Mill.	Location.	Leffel Turbine	Overshot	Hurdy-Gurdy	Diameter, in Feet or Inches	Knight	Diameter, in Feet or Inches	Pelton	Diameter, in Feet or Inches	Donnelly	Diameter, in Feet or Inches	Head or Pressure, in Feet.	Volume of Water, or Miner's Inches Required	Machinery Driven.
	Calaveras.													
Angels	Angels									1	4 ft.	146	43	3 Low mills.
										1	20in			4 Frue vanners.
Nevills, or Stickles	Angels									1	6 ft.	250 to 175	50	20 stamps, 950 pounds each.
										1	6 ft.			Compressor.
										1	5 ft.			Pump.
Utica	Angels					1	6 ft.					98	172 to 173	20 stamps, 900 pounds each.
								1	3 ft.					8 Frue vanners.
McCreight	Near Angels		1		40 ft.							0	76to77	10 stamps, 650 pounds each; 1 Frue vanner.
Russell Red. W'ks	Near West Point					1	4 ft. 6 in.					110	250	5 stamps, 850 pounds each; Dodge pulverizer, 4 pans, 2 settlers, 2 Frue vanners, rock breaker.
Suffolk	Angels		1		40 ft.							0		
			1		28 ft.							0		
			1		24 ft.							0	40	5 600-pound stamps.
Quaker Gold Mine	Near Mokelumne Hill					1	4 ft. 6 in.					180	10	Hoisting machinery.
								1	4 ft.			225	20	6-foot Huntington.
Penn Chem. W'ks	Campo Seco							1	5 ft. 6 in.			190	17½	Hoisting machinery and pump.
								1	5 ft. 6 in.			190	17½	Revolving cylinder.
	El Dorado.													
Josephine	Volcanoville					1	4 ft. 6 in.					320	50	10 stamps, 850 pounds each; 10 stamps, 750 pounds each; 8 Triumph concentrators.
						1	3 ft.					295	15	Hoisting works.
Alpine	Near Georgetown							1	4 ft.			280	15to20	10 stamps, 1,000 pounds each; 3 Duncans.
								1	1 ft. 8 in.			280	5	Rock breaker.
Taylor	Near Georgetown							1	3 ft.			220	20	Hoisting works.
								1	4 ft.			220	20	10 stamps, 750 pounds each.
								1	18 in.			220		Rock breaker.

Gopher & Bowlder	Near Kelsey					1	6 ft.					320	71	20 stamps, 750 pounds each.
						1	22 in.							
Church	Near El Dorado							1	6 ft.			475	14	10 stamps, 850 pounds each.
								1	6 ft.			475		Cornish pump.
Big Cañon	Near Shingle Springs							1	3 ft.			365	54	20 stamps, 850 pounds each.
								1	2 ft.			365		Rock breaker.
Pacific	Placerville			*1	6 ft.							274	50	Rock breaker.
				1	8 ft.							274		20 stamps, 800 pounds each.
						1	4 ft.					210	30	Hoisting works.
						1	4 ft.					295	20	Compressor.
Oregon	Placerville			1	8 ft.							250	25	10 stamps, 750 pounds each.
True	Near Placerville			1	8 ft.							450	10	10 stamps, 550 pounds each.
Melton	Grizzly Flat					1	4 ft. 6 in.					96		15 stamps, 800 pounds each.
Linden Gravel	Near Placerville							1	4 ft.			200	10	10 stamps, 550 pounds each.
Mathien's Creek	Near El Dorado					1	3 ft.					70	44	5-foot Huntington mill.
Chile Ravine	Near Placerville							1	4 ft.			350	10	10 stamps, 550 pounds each.
Rogers	Near Placerville					1	4 ft.					60	50	10 stamps, 500 pounds each.
			1		44 ft.							0	5	8-inch Cornish pump.
Equator	Near El Dorado							1	4 ft.			150	65	Compressor and 2 drills.
	Tuolumne.													
Madrid	Tuttletown					1	4 ft. 6 in.					120	29	5 stamps, 650 pounds each.
Patterson	Tuttletown					1	6 ft.					230	64	20 stamps, 800 pounds each.
San Guisseppa	Sonora		1		20 ft.							0	70 to 80	Hoisting works and 10-foot arrastra.
			1		11 ft.							0		4-inch Cornish pump.
App	Jamestown		1		16 ft.									5 625-pound stamps.
Gem	Jamestown		1		32 ft.							0	60	10 stamps, 650 pounds each.
Heslep	Jamestown		1		50 ft.							0	263	25 stamps, 850 pounds each.
Experimental	Near Columbia							1	4 ft. 6 in.			80	47	Blanding crusher and 10 stamps, 650 pounds each.
Black Oak	Near Soulsbyville		1		20 ft.							0	60	2 4-inch pumps.
Totals		3	10	4		48		39		28				

*Morey pattern.

The head in feet multiplied by twelve gives a column of square inches above a surface one inch square, and as one thousand seven hundred and twenty-eight cubic inches of fresh water equal sixty-two and one half pounds avoirdupois, twelve inches, or one foot head, gives a pressure of four hundred and thirty-four thousandths pounds per square inch, or two and three tenths feet of head equal one pound pressure per square inch.

To obtain the volume of water in miner's inches, measure with the box in use or take the area of a cross section and multiply by the velocity and convert the cubic feet per minute into miner's inches. Of course, none of the wheels develop the entire theoretical power unless allowance is made for loss by friction in the pipe, friction in the nozzle, loss of head in the nozzle, friction of the water leaving the bucket, power lost in water lifted by the wheel after the water has done its work, friction of journals, loss by impact against the wheel by generation of heat, resistance of the air, etc. It is claimed for some of the wheels that these combined losses under certain heads do not amount to 10 per cent.

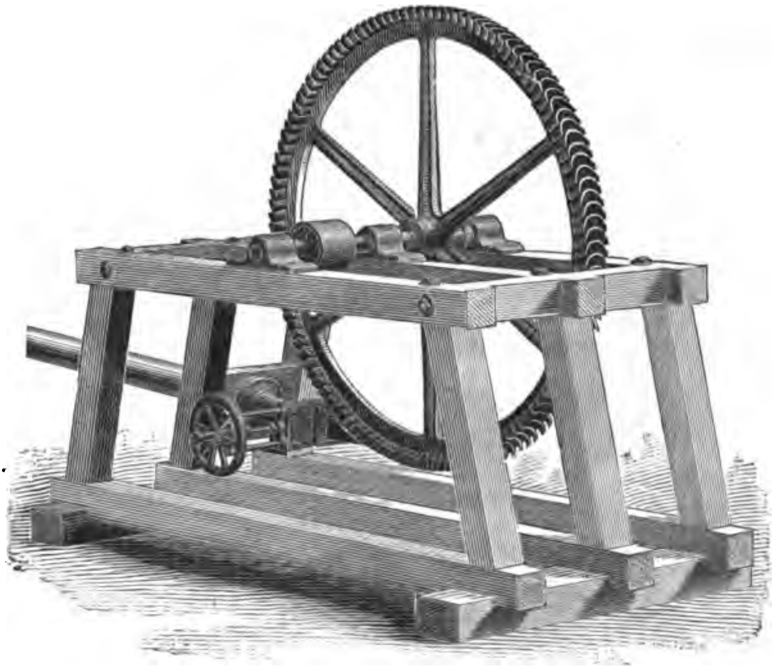
There are one hundred and thirty-three water wheels driving hoisting, milling, and accompanying machinery in the counties of Amador, Calaveras, El Dorado, and Tuolumne. Of the wheels employed there are:

Ten ordinary overshot.
Four hurdy-gurdys, Morey.
Three turbines, Leffel.
Two turbines, Knight.
Forty-six pressure or tangential, Knight.
Thirty-nine pressure or tangential, Pelton.
Twenty-eight pressure or tangential, Donnelly.
One pressure or tangential, Lepley.

A legally measured miner's inch of water in California is that quantity which will flow through an opening one inch square in the bottom or side of a vessel under a pressure of four inches above the opening; this definition gives a mean pressure of four and one half inches, and allows less water than the ordinary measurement of the principal canal companies in the State.

Ditch Companies.	Thickness of Plank through which the Water Issues	Opening, in Inches	Pressure above Top of Opening, in Inches	Mean Pressure, in Inches	Cubic Feet per Minute	Gallons per Minute	Gallons per Twenty-four Hours—approximate
Blue Lakes Water Company	2	2	4	5	1.4	10.47	15,077
El Dorado Water and Deep Gravel Company	2	2	5	6	1.45	10.84	15,609
Park Canal and Mining Company	1½	2	5	6	1.45	10.84	15,609
California Water Company	1½	2	6	7	1.57	11.74	16,905
Mokelumne and Campo Seco Canal and Mining Company	{ 2 1	3 4	4 4	5½ 6 }	1.43	10.70	15,408
Union Water Company, Murphys	1½	4	4	6	1.45	10.84	15,609
Tuolumne Ditch Company	2	3	4	5½	1.43	10.70	15,408
South Yuba Canal Company	1½	4	4	6	1.45	10.84	15,609
North Bloomfield	3	2	6	7	1.5744	11.77	16,949
La Grange	3	2	6	7	1.5744	11.77	16,949
Milton	3	2	6	7	1.5744	11.77	16,949
Smartsville	1½	4	7	9	1.78	13.32	19,180
Average	2	3	5	6½	1.512	11.30	16,272

THE KNIGHT WATER WHEEL.

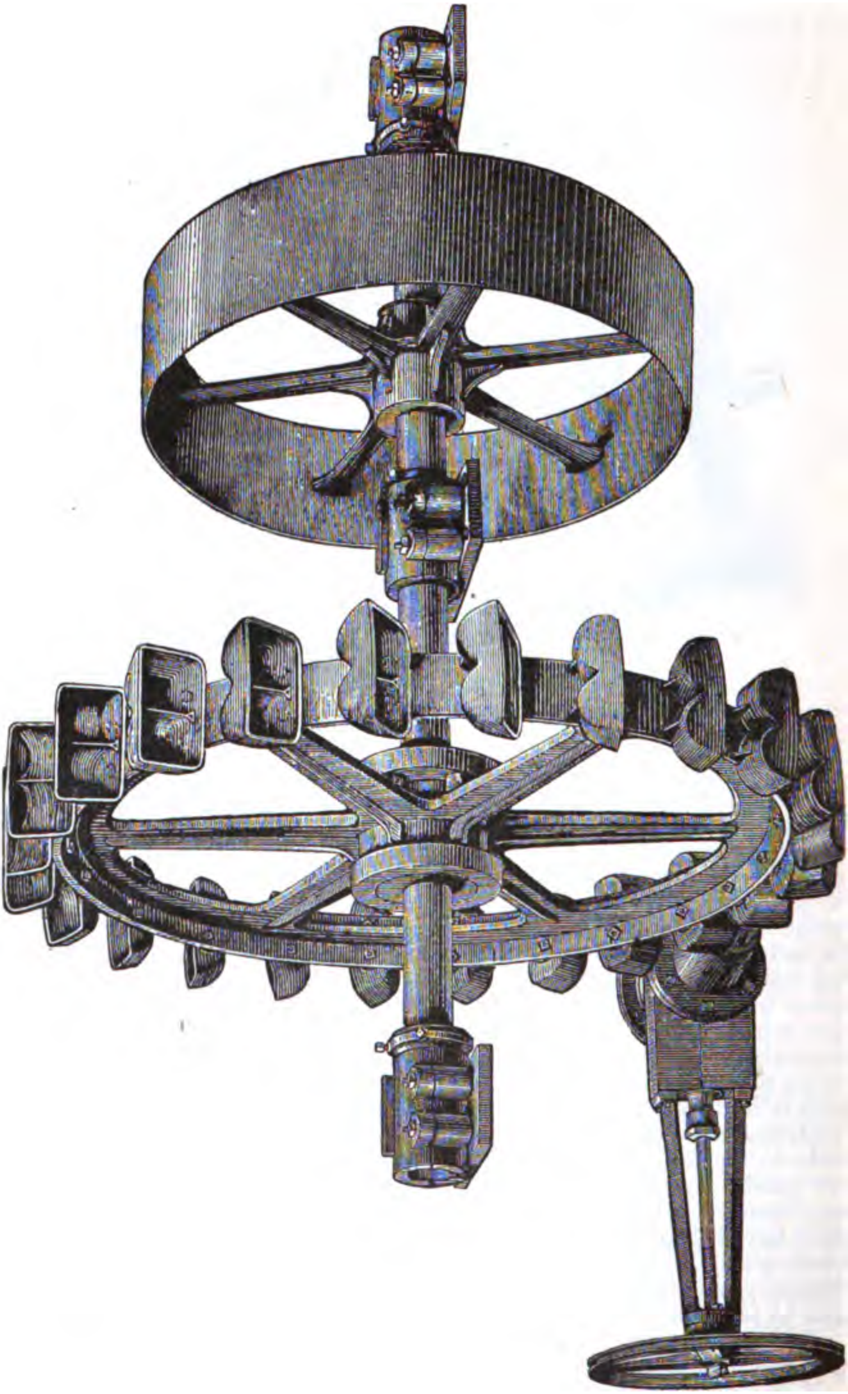


THE KNIGHT WATER WHEEL.

One of the most important features in mining economy is the cheap furnishing of power for the operation of the different kinds of machinery employed; the ever increasing scarcity of fuel, and the annoyance and expense attending the cutting and hauling and storing of same, has compelled the careful operator to look about for other and less expensive means of power before embarking in his mining enterprise. He naturally turns to the water supplies, and finds abundant encouragement in the water to be had from the various ditch companies, from private sources, and from the utilization of heads of water heretofore unused on account of the distance from the place where the power is to be used. This last problem is now attracting a great deal of close attention from careful engineers, with surprising results. In California and, in fact, all along the Pacific Slope, owing to the altitude of our mountain ranges and the depth of our cañons, high falls of water are for the most cases readily obtained, and this feature is particularly desirable, because the quantity of water used is the inverse ratio to the fall. In the Eastern States most of the water powers have low heads, and the turbine water wheel is the motor best suited to their requirements; while here the turbine is practically useless, and our conditions have led to the development of a class of water wheels, known as the hurdy-gurdy or tangential wheels, which are simply marvelous in their efficiency, as high as 90 per cent being realized under special conditions, and 85 per cent being an every day running proposition.

These wheels are made from six inches in diameter to a size that will give one thousand horse power.

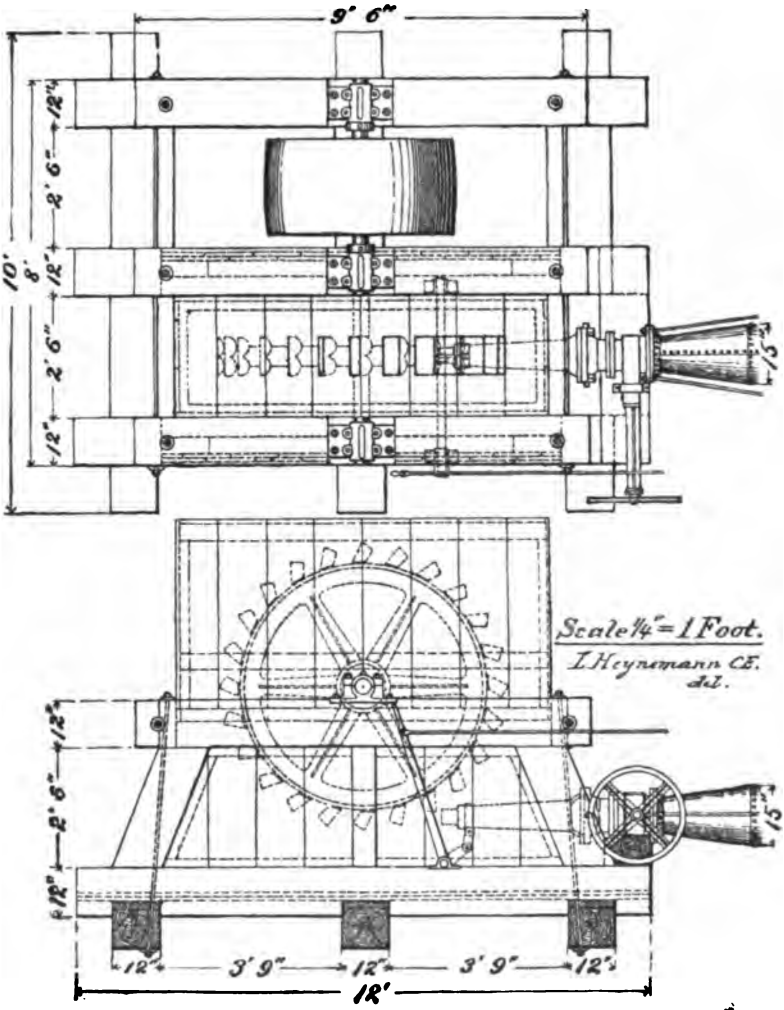
More detailed description of the Knight wheel can be had by applying to Knight & Co., Sutter Creek, Cal.



THE PELTON WATER WHEEL.

THE PELTON WATER WHEEL.

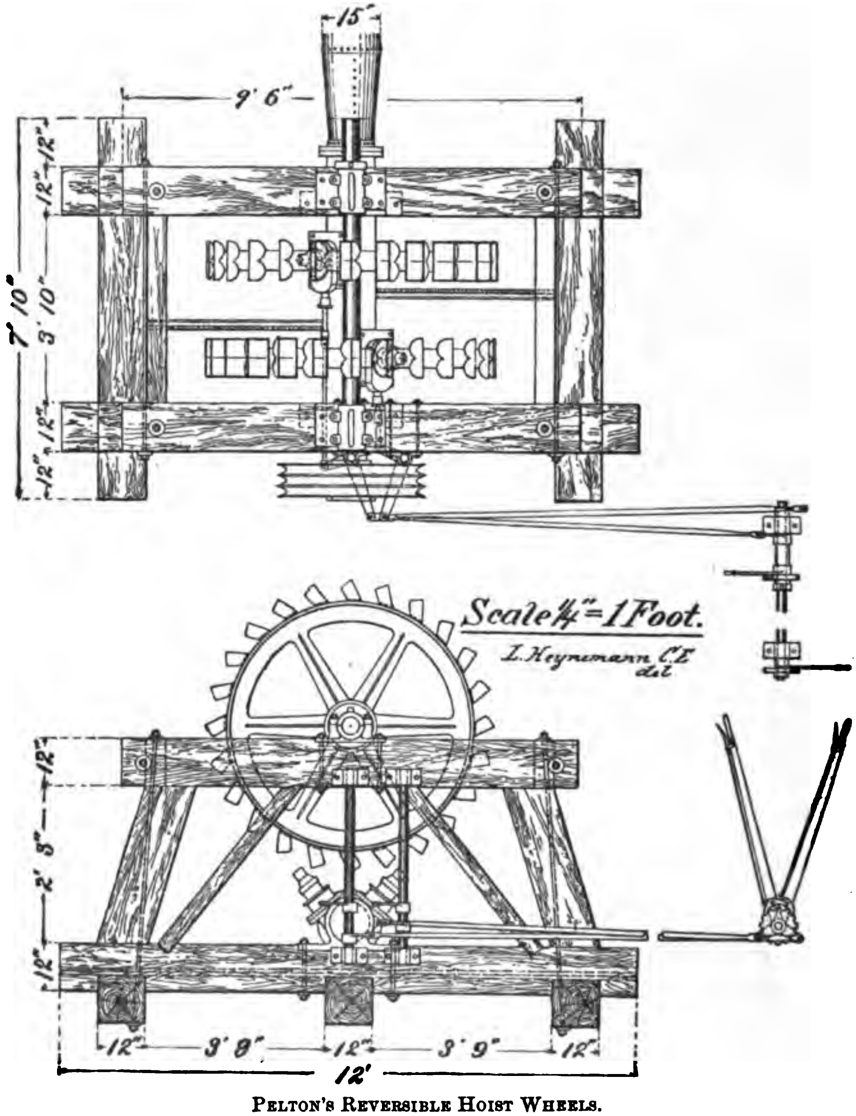
It is claimed by the manufacturers that the shape of the bucket, in which a wedge is introduced dividing the stream, allows of a freer discharge of water from the wheel, and lessens the quantity of the water carried and lifted by the wheel.



PELTON'S SIX-FOOT WATER WHEEL WITH A DEFLECTING NOZZLE.

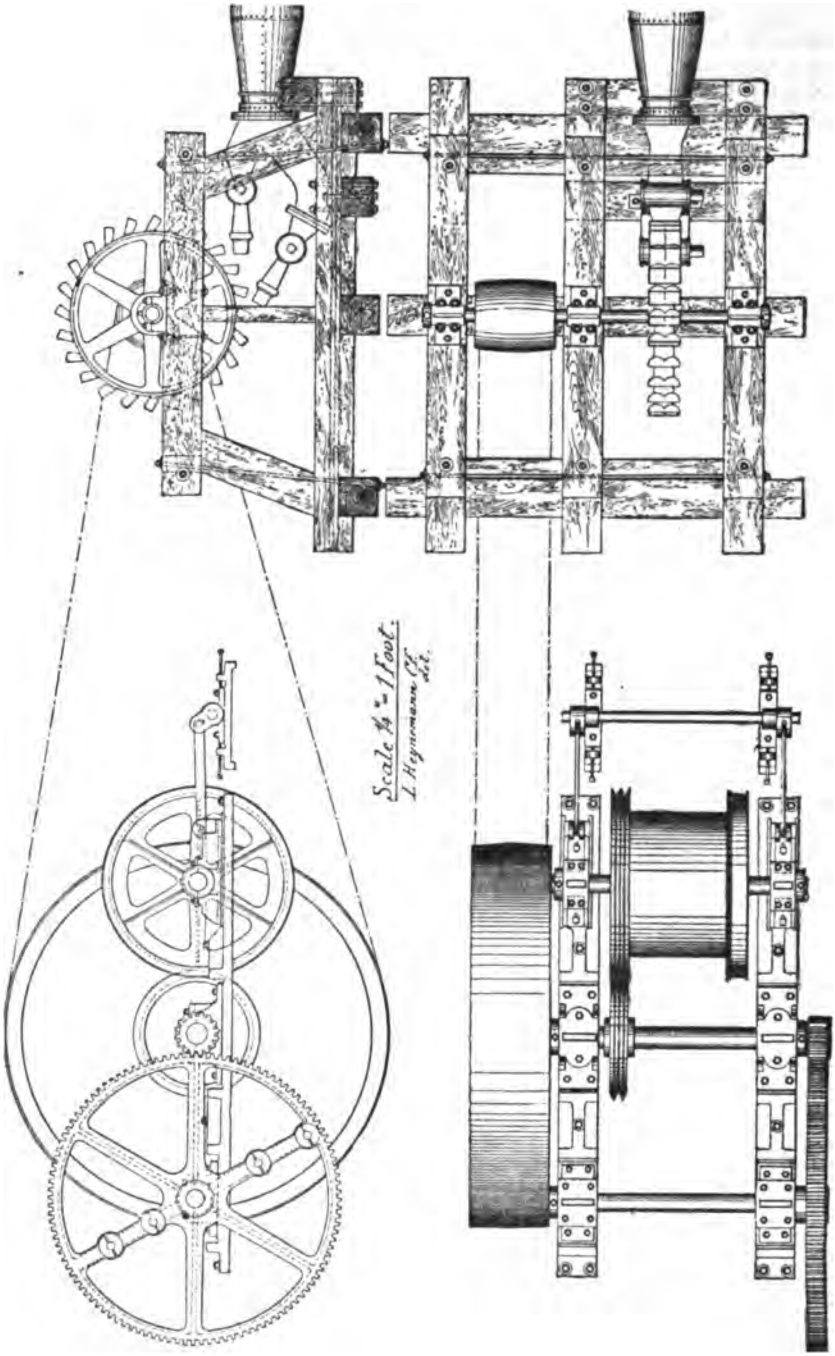
"The above wheel is shown in connection with a gate, having a deflecting nozzle which may be used with any diameter wheel. This nozzle is operated by means of the lever and rock-shaft shown in the cut. With this appliance the whole stream, or any part of it, may be thrown into the wheel or out of it instantly, and the gate back of it closed at leisure.

"The cut also shows the method of housing in all Pelton wheels."



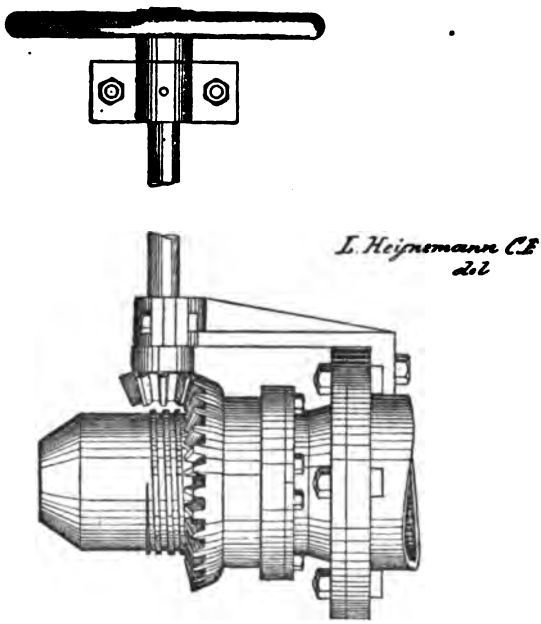
Pelton's Reversible Hoist Wheels.

"The above cut represents two six-foot Pelton water wheels placed on one shaft, to be run in opposite directions, thus reversing the motion of the shaft, and is intended for hoisting from double or single compartment shafts or inclines, where power is required for lowering the cars or cages either empty or loaded."



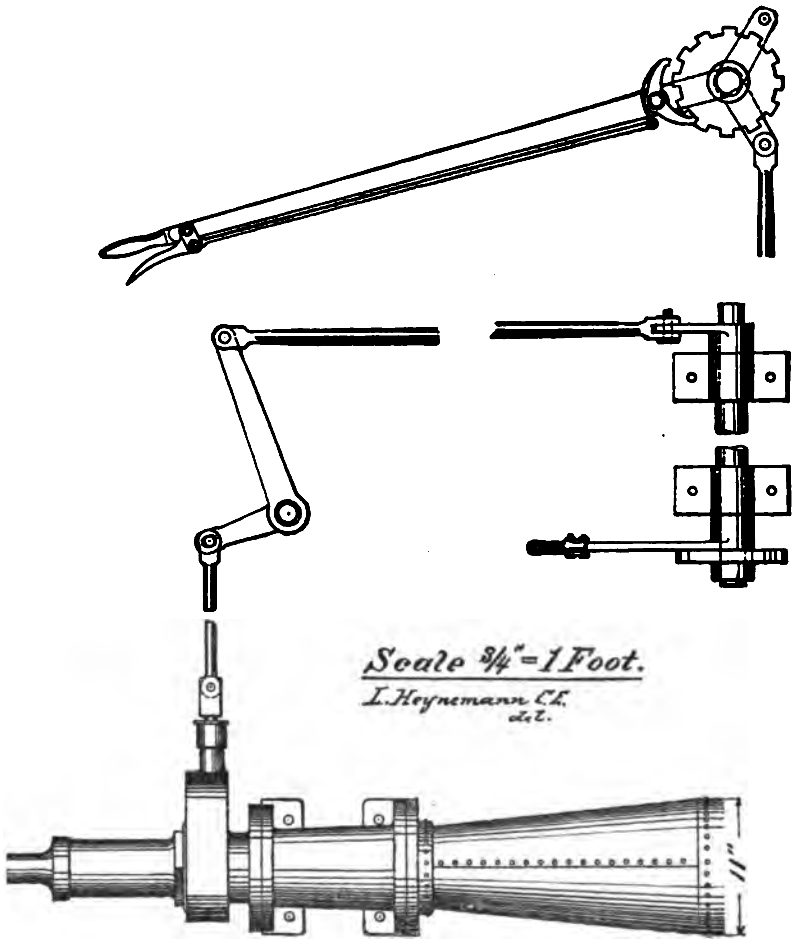
PELTON'S FOUR-FOOT WATER WHEEL, WITH TWO STREAMS APPLIED.

"The wheel is represented as having two streams of water applied, and is intended to double the capacity of the wheel for regular work, or for hoisting and pumping with one wheel, as shown in the cuts. For pumping and hoisting, the stream for the pump is left running constantly, while that for the hoist is opened and closed for each load, thus economizing in water."



VARIABLE NOZZLE.

"The above cut represents a contracting nozzle that may be varied 60 per cent in area by turning the hand wheel, and can be attached to the outlet of a gate suitable for its supply."



"The above cut represents a water gate and appliances for operating it."

ELECTRIC TRANSMISSION ON THE COMSTOCK LODE.

A most interesting application of electric transmission for mining uses is about to be tested on the great Comstock lode at Virginia City, Nevada.

An eleven-foot Pelton wheel for the past two years has been running the Nevada Mill, supplied by water from the Virginia and Gold Hill Water Company, under a pressure of four hundred and sixty feet.

This mill, having been recently doubled in capacity, large additional power is required, which is to be obtained in the following manner: The water, after running over the surface wheel, is conveyed down the Chollar shaft through heavy wrought iron pipe. At the Sutro Tunnel level, some sixteen hundred feet from the surface, are placed six dynamos of one hundred and twenty-five-horse power each. A forty-inch Pelton wheel is attached to the shaft of each of these dynamos, which will be run under a direct vertical pressure of one thousand six hundred and thirty feet.

A single pipe conveys the water for these six wheels, with branch connections to each. Nozzles three eighths of an inch in diameter under this head will develop in each dynamo one hundred and twenty-five-horse power. The wheels, for additional security, are made of phosphor bronze, and will run at nine hundred revolutions per minute. The power thus generated is to be conveyed to the surface, and from thence to the mill, some three hundred feet distant. The Pelton wheels are expected to work up to full 90 per cent efficiency, and it is thought that from 75 to 80 per cent of the power which is furnished will be available at the mill.

This is, perhaps, the first attempt made to run wheels under such enormous pressure, and the result of this experiment, as well as in the matter of the transmission of power, will be watched with much interest.

The equipment at the Big Bend Tunnel, in Butte County, consists of a four-foot Pelton wheel, running under three hundred-foot head, and placed one mile below the mouth of the tunnel. The wheel runs the dynamo, the power of which is conveyed over an eighteen-mile circuit, for the purpose of running pumps and derricks at sixteen different stations on the line. Only a portion of the stations have been equipped at this writing, but, so far as tested, the operation is understood to be every way satisfactory.

ELECTRICAL HOISTS.

The first application of electricity to hoisting works for mining purposes in the West, is at the Veteran Tunnel at Aspen, Colorado. The power is furnished by a Pelton wheel, the water for which is run through a twenty-inch pipe from a flume, under a seventy-foot head, with a three-inch discharge nozzle. A governor is attached to the wheel gate, affording perfect regulation as the load is thrown on or off.

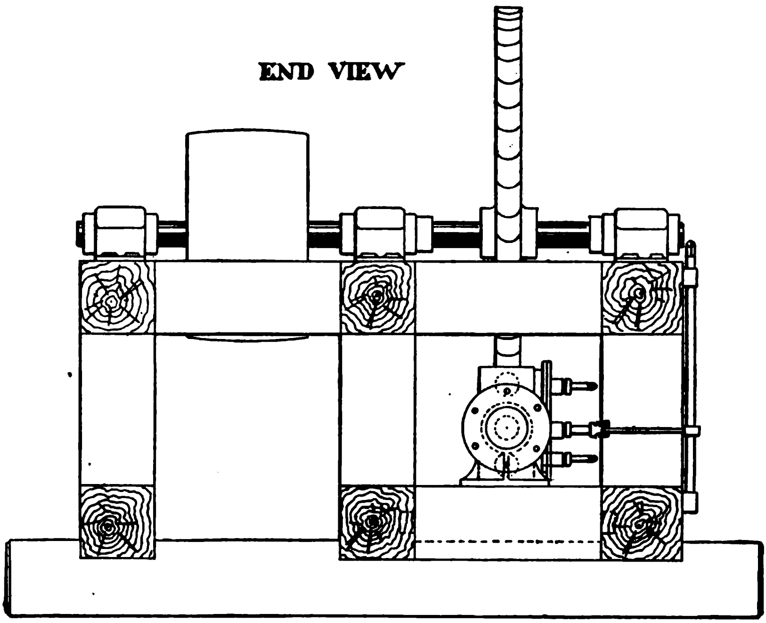
The wheel is located six thousand five hundred feet from where the power is applied, and drives a five hundred-volt Edison dynamo, which converts into electrical energy 92 per cent of the power thus developed. The wheel works up to 90 per cent efficiency, and the energy available for work at the motor pulley is 74 per cent of the water from the wheel.

The speed of the motor is controlled by a switch, which also starts, stops, or reverses it, as may be desired. The motor operates a hoist over a shaft two hundred feet in depth; also runs a train of nine cars through a tunnel one thousand feet in length. Formerly one man was required to each car, taking twenty minutes for the round trip. Now the entire train is run out and returned by one man in eight minutes.

Further description, with tables of power, etc., can be obtained from the Pelton Wheel Company, San Francisco.

THE DONNELLY WHEEL.

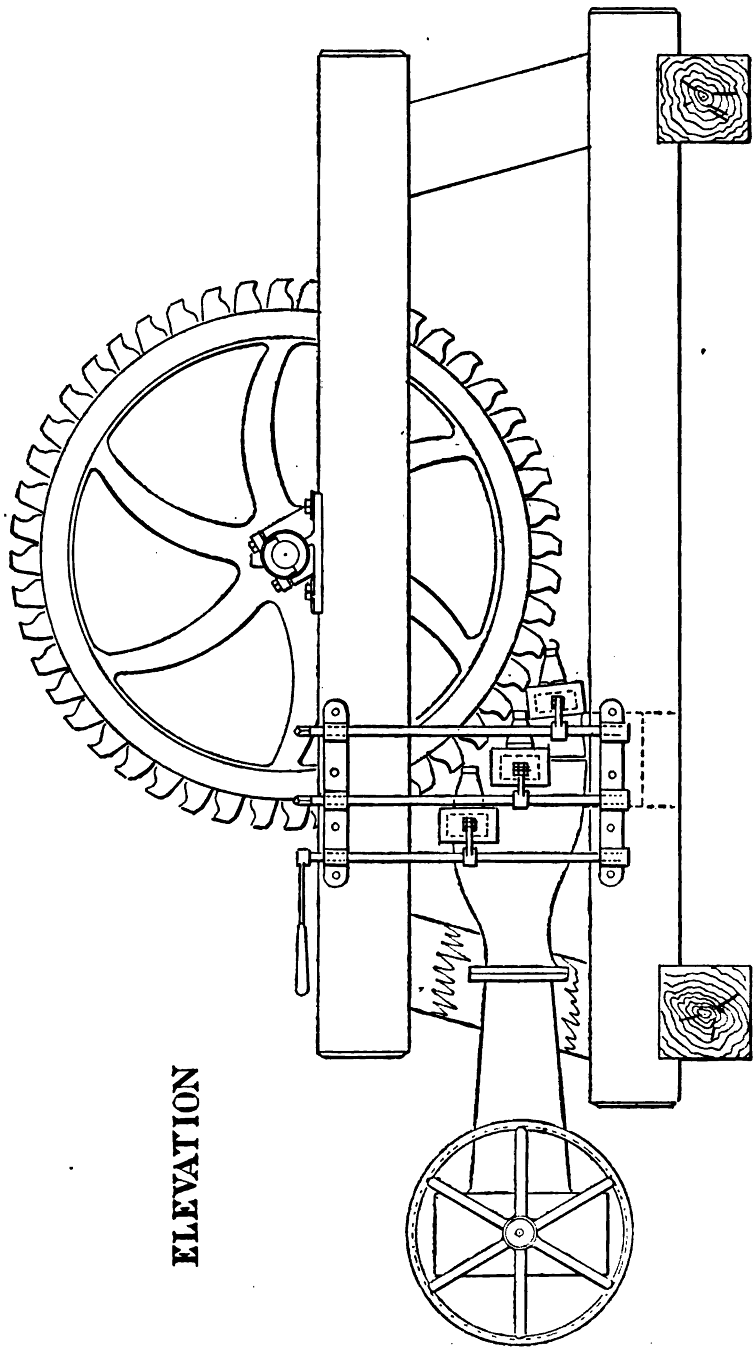
This wheel was patented in March, 1882. The buckets are riveted on to, and not cast, with the wheel, as is the case with the Knight; the jet of water impinging on the wheel is not split by a peculiar construction of bucket, as is the case with the Pelton, but the Donnelly bucket has a very favorable shape for allowing a free discharge of water from the wheel, as soon as the force due to the weight of the water has been imparted. The manner of the application of the water to the wheel, as well as the shape of the bucket, is one of the chief points of merit. The round nozzle is used



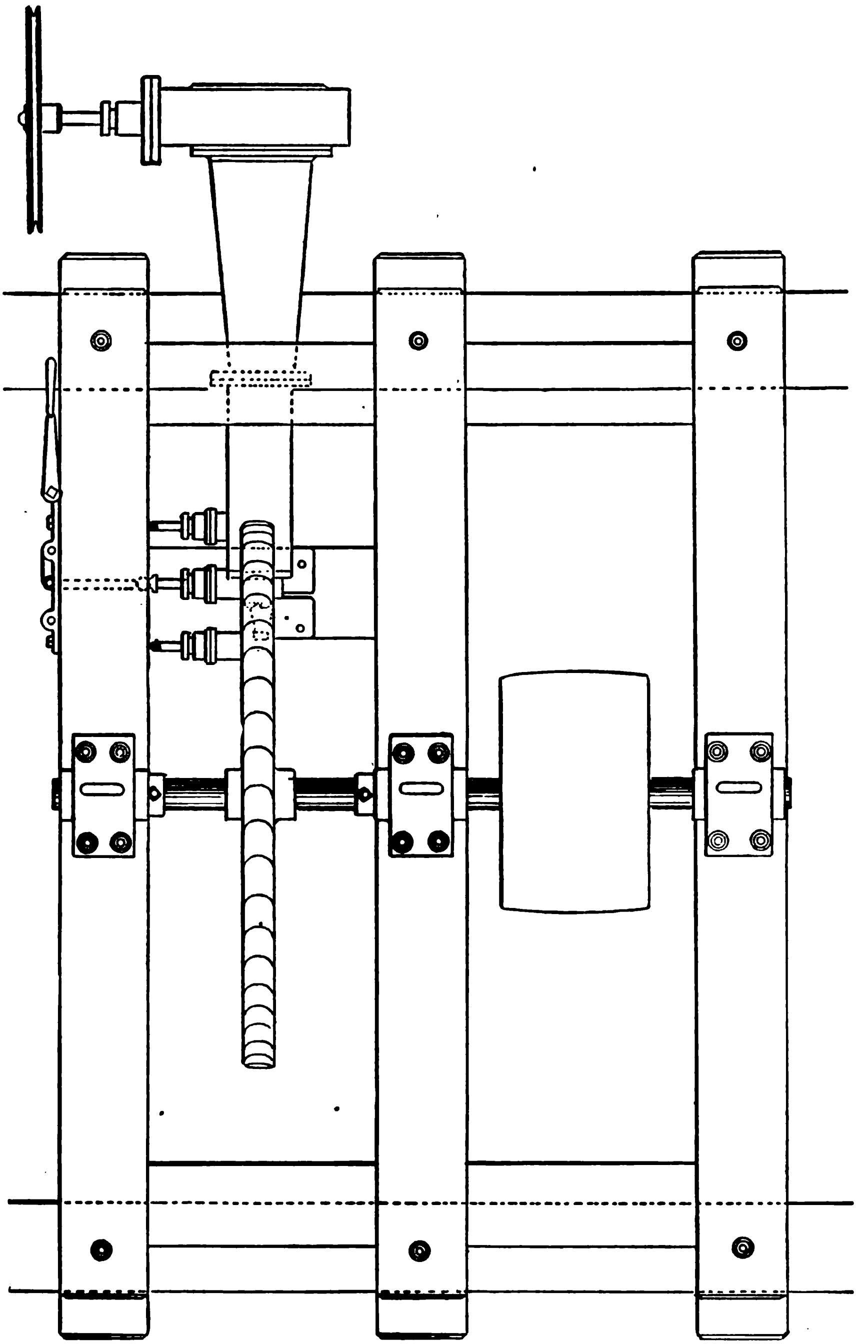
DONNELLY'S WHEEL.

in applying the water, instead of the elliptical or oblong nozzles, which are best adapted to the peculiarity in the shape of the Knight bucket. During the last four years quite a number of these wheels have been called into requisition in the counties of Amador, Calaveras, El Dorado, and Nevada, and in all instances they have given satisfaction. The amount and character of the machinery driven by the Donnelly wheels, now in operation in the mines and mills of Amador and Calaveras Counties, may be seen by referring to the tabulated statement of water wheels. A notable instance of the efficiency of these wheels is presented at Plymouth, Amador County, where one of them, under five hundred and sixty-one feet of pressure, drives the eighty stamps of the Empire Mill with seventy-five measured miner's inches of water; another instance may be cited of the Seaton Mill, near Drytown, containing twenty stamps driven by forty-two inches of water applied to a Donnelly wheel, under two hundred and thirty feet of pressure. These examples are given because circumstances allowed easy and exact measurement of the water. The Donnelly wheel, like the Knight and Pelton, belongs to the order of "hurdy-gurdy" tangential or pressure wheels.

ELEVATION



DONNELLY'S WATER WHEEL.



THE LEPLEY WHEEL.

This wheel is constructed by riveting buckets of a peculiar pattern on the sides of a wrought iron disk. The first wheel of this design was made in 1876, and one may be seen in operation at the Keystone Mine, in Amador City. The diameter of this wheel is four feet six inches, and it operates in this instance under two hundred feet of pressure. The bucket is so shaped that the water after communicating its force to the wheel radiates instantly to the ground from near the center of the bucket, and a glimpse of the wheel under application of water may quickly demonstrate that very little if any water is "backed" or carried with the wheel and lifted in being discharged from the bucket, at the expense of pressure due to the actual head. In the Pelton the stream striking it is divided by a wedge in the center of the bucket, thereby assisting the water to free itself from the wheel. In the case of the Lepley nearly the same result is accomplished by the use of a bucket having somewhat the shape of a hollow heart, the water striking the raised portion of the heart outline in the center, the result being the instant radiation of the water after the force is communicated to the wheel; the shape of the bucket permits the use of the round nozzle.

THE MOREY WHEEL.

This is essentially a cast-iron "hurdy-gurdy" wheel, where the pressure is direct upon the bucket, which is not constructed with a view to the freest discharge of water after the performance of work, nor to save all the energy of the jet impinging on the wheel. A large number of these wheels are still in operation, especially in El Dorado County. This wheel may be considered as the first movement in the evolution of a high type of a pressure wheel from the wooden "hurdy-gurdy" with "sawteeth" buckets.

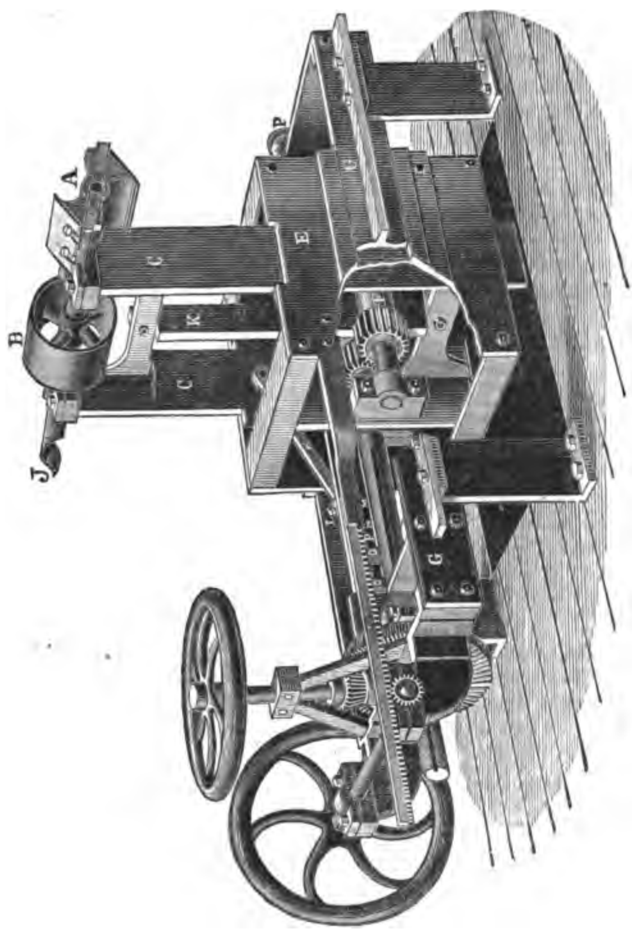
THE OVERSHOT WHEEL.

This wheel is too well known to require special notice, excepting perhaps by way of apology, as very many are used where the volume of water precludes the use of the turbine, and the head and quantity of water are very much limited.

LEPLEY'S FRAMING MACHINE.

It is claimed that any form of cut, tenon, mortise, gain, or dovetail, in timber of any size, can be made with this machine.

One of these machines has been in constant use at the Keystone Mine, at Amador City, for many years, giving great satisfaction. One machine has also been introduced at the Zeile Mine, at Jackson, and the Superintendent speaks most highly of it. Where a great deal of framing of heavy timbers is necessary it is not only a labor saving machine, but the work is done with accuracy, and often, where "time" is a very important item in the accomplishment of work, it is as essential in the attainment of this object as is the power drill.



LEPLEY'S FRAMING MACHINE.

NOTES ON WESTERN LEAD SMELTING.

By W. S. KEYES, Mining Engineer and Metallurgist, Trustee State Mining Bureau.*

Early in May, 1866, the writer hereof assumed charge as General Manager of the smelting and reduction works of the St. Louis and Montana Mining Company, situated at the town of Argenta, Beaver Head County, Territory of Montana. These works consisted of a so called double Freiberg shaft furnace, an engine to drive the fan blast, and a large German cupel furnace. They were built by Mr. Augustus Steitz, of St. Louis, a most promising and accomplished metallurgist, whose devotion to his chosen profession caused his untimely death, but not until he had made many valuable improvements and suggestions in the art of metallurgy. Among other things he invented a water-lined, copper cupel bottom, hung upon an axis, so that by gradually raising the test the litharge, as fast as it formed, could easily flow off from the surface of the molten lead.

Many difficulties arose in this, at that time, remote region to hinder the successful smelting of the ores, such as they were. The workmen were inexperienced, charcoal was difficult to obtain and of inferior quality, coke could not be had, and even clay for furnace, hearth, and cupel bottoms was remote and scarce. Worst of all the mines were insufficiently opened to keep up a regular supply of ores for smelting. At these works was made the first serious attempt at regular smelting in the far Western Territories. Hitherto the backwoods hearth, the Scotch hearth, and its improved congener, the American hearth, such as were to be found in the lead mines of Illinois and Missouri, were the only forms of smelting apparatus known in the far west. This double shaft furnace represented at that time a very fair model of the blast furnaces used in Germany for the reduction of lead ores. Figures 1, 2, and 3 of Plate I, taken from the drawings made at Freiberg, in Saxony, Germany, give all the necessary plans of such a furnace. Figure 1 represents a section through the breast from front to rear. Figure 2 represents a section through the furnace at right angles to Section 1. Figure 3 represents a ground plan of the hearth with the accompanying tap basin and tap canal.

The pillars inclosing the furnace were made of granite or gneiss, having a face of over three feet, and alone contained material almost sufficient for the whole of a modern furnace. A fire brick lining extended from the ground floor of the furnace to a point about one foot and a half above the tuyeres. It will be observed in the section, Figure 2, that a partition wall extends from the top of the furnace downwards, to a point about two and a half feet above the level of the tuyeres. This wall rests upon an arch sprung from front to rear of the furnace, and was made of common brick in the upper portion, and of fire brick in the lower courses. The object of this wall was to insure a uniform descent of the smelting mixtures. The bottom or hearth of the furnace was composed of a mixture of charcoal or coke dust and clay, well tamped in, beneath which are depicted a mass

* The writer takes pleasure in expressing his obligations to the talented and able metallurgist, Mr. O. H. Hahn, of Colorado, whose notes have furnished some of the most valuable practical hints and suggestions for this article.

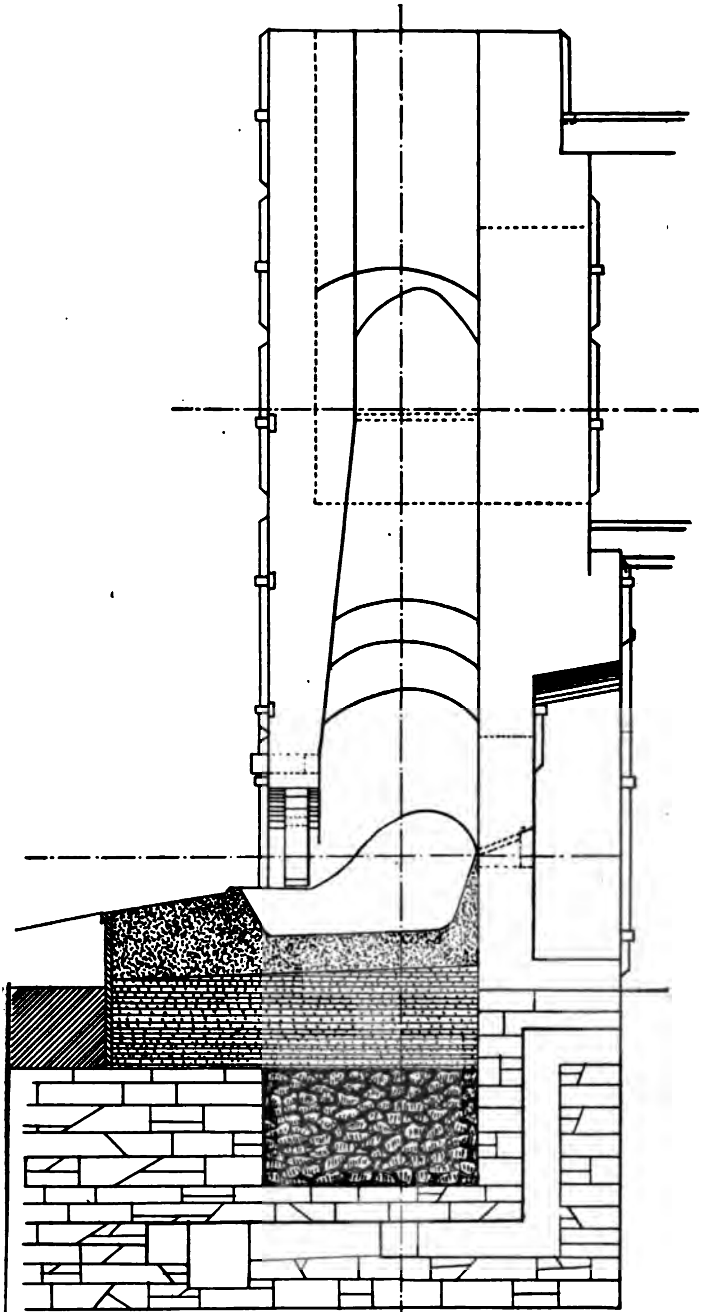


PLATE I, FIGURE 1.—SECTION.

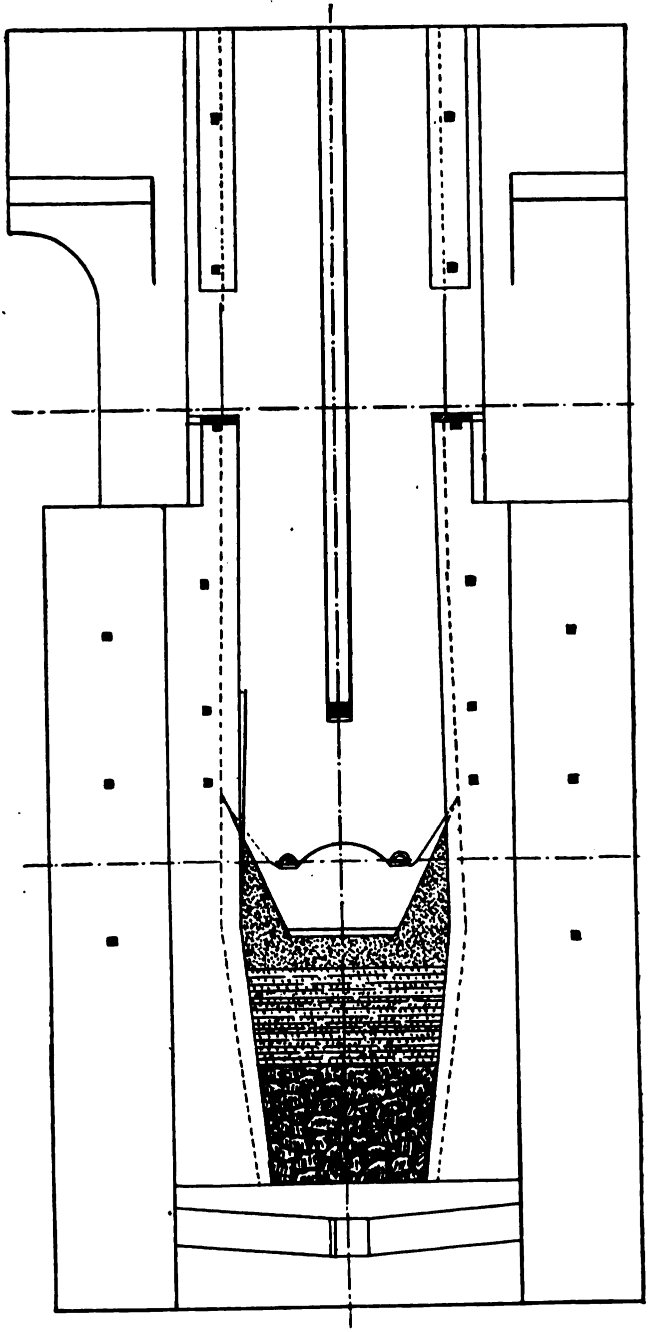


PLATE I, FIGURE 2.—SECTION.

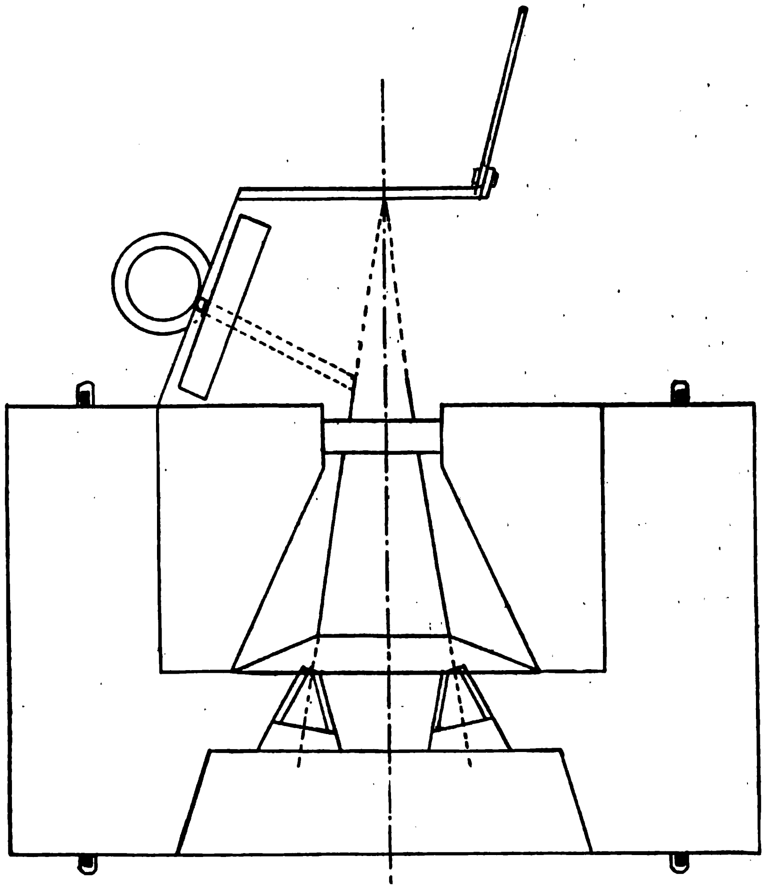


PLATE I, FIGURE 3.—GROUND PLAN.

of rubble, which served as an exit for the moisture contained in the brasque. A hole was cut through the hearth lining to the exterior tap basin. The furnace was capable of smelting in twenty-four hours from six to ten tons of ore. The Montana ores, which were to be treated, consisted of the oxides, carbonates, sulphates, and sulphurets of lead, usually found in the magnesian limestones of the far Western States and Territories. They afforded an ample percentage of lead for smelting, and were more than usually rich in silver, two hundred and three hundred-ounce ores not being uncommon. They did not require any considerable amount of iron for fluxing. The price paid for smelting was $100 per ton. Nevertheless, on account of breakdowns and delays, bad charcoal, inexperienced workmen, and an irregular supply of ore, the works were not a financial success, and under the advice of the writer were closed down and smelting was discontinued. The work-lead or base bullion obtained by smelting was cupelled in a large German cupel hearth, and thirty tons were put through in the space of three days and two nights. The resulting cake of silver was broken up, cast into molds, and shipped to its destination.

In 1867 the Trinity and Sacramento Mining Company acquired certain mines in the vicinity of Oreana, in the State of Nevada, and erected works for the benefication of the ores. The ores were docile, but contained a large amount of antimony. A fair average, perhaps, would be some 30 per cent of the latter metal. Much of the ore was rich, in value from $80 to $200 in silver per ton. The furnaces were somewhat similar in form to that already described at Argenta; they were, however, thirty inches square, and were capable of reducing in twenty-four hours, about eight tons of ore. The base bullion so obtained required a preliminary calcination before it was cupelled. This calcination was performed in an iron pan thirteen feet long, five and one half feet broad, and ten inches deep, with an initial charge of twelve to fifteen tons. As the lead was purified an additional amount was added until from twenty to twenty-five tons would be more or less thoroughly purified. This process required about ten days. The lead was then cupelled in a long cupel hearth with movable tests set upon wheels. The test was made of an oval iron frame, five feet long, about forty inches wide, and was filled with a mixture of bone ash and willow ashes. So impure was the work-lead as it came from the smelting furnace, that a bar when cold, if carelessly let drop, was often broken in two. This cupellation of the lead *in situ* was rendered necessary from the fact that the overland railroad had not yet reached Oreana, and the long haul to a market wholly ate up the value of the lead. As soon, however, as the railroad was completed to this point the base bullion was sent to San Francisco to be refined.

In 1870 several smelting furnaces, mostly small, were built at and near Shermantown, Swansea, and Hamilton, White Pine County, Nevada. One of these, situated at Swansea, and originally built by Joseph Moshemier, of San Francisco, was under the charge of the writer and Mr. O. H. Hahn. The smelting ores of White Pine County, at and near Hamilton, were eminently basic. They were poor in silver, but abundant in lead carbonates, and in so far desirable and easy to treat. Owing, however, to an absence of quartz in the ores themselves, and the difficulty of obtaining siliceous ores for fluxing purposes, their reduction gave rise to the formation of "sows" innumerable, which hindered the smelting, and often necessitated the blowing out of the furnace. These works produced, in the course of a few months, above one thousand tons of base bullion, and resulted in a gross financial loss of $30,000, after which experiment the furnaces were closed down and smelting abandoned. A like fate befell all the smelting furnaces in the vicinity of Shermantown and Swansea. There was no possible profit in smelting. The ores were exceedingly poor, and the owners of the mines asked such a price for them that the furnaces were unable to exist.

A curious fact in connection with smelting at this place may here be noted, viz.: the behavior of mountain mahogany charcoal in the blast furnace. This wood, as is well known, is of a very firm, compact texture, and in the process of carbonization becomes thoroughly burnt out, so to speak; and, as a result, when this charcoal is put into the furnace and the charge thrown upon it, it becomes crushed to an almost impalpable powder, so that the blast cannot force its way through, and, strange as it may appear, this fuel actually put the fire out. So pressing was the need of siliceous ore for fluxing, that Mr. Hahn and the writer cast about them for a substitute. They hit upon the use of the clay slates, which were quite abundant in the neighborhood, and this was, as far as the writer is aware, the first attempt to make aluminate instead of silicate slags. The experiment proved a success.

Not deterred by the ill luck of the foregoing furnaces, ex-Governor Matteson, in the year 1870, proceeded to erect three blast furnaces and five roasting furnaces in the town of Hamilton. After smelting for a short time, these works were discontinued. In 1871, as far as the writer can recall, not a single stack was in blast in White Pine County, Nevada. Meanwhile, more appropriate ores had been discovered at Ruby Hill, near what is now the town of Eureka, Eureka County, Nevada, then known as Napias, Lander County, Eureka County having subsequently been formed from the eastern portion of Lander County. Mr. C. A. Stetefeldt, the well known metallurgist, had built a small furnace to work the ores of New York Cañon, which is about two miles easterly from Ruby Hill. The ores proved unsuitable for smelting and the attempt was abandoned. A Mr. G. C. Robbins subsequently built a small draft furnace for the smelting of the rich carbonate ores, and succeeded in getting some base bullion. Messrs. Buel & Bateman were more fortunate. They had, with the assistance of some Cornish smelters, built some stone furnaces to reduce the ores of Ruby Hill. Though the furnaces were of small capacity, the ores were so docile that economically favorable results were readily obtained. The principal mines of Ruby Hill were, in the latter part of 1870, sold to a San Francisco corporation, then and since known as the Eureka Consolidated Mining Company. In January, 1871, the writer assumed charge as General Manager of these mines and works. He called to his assistance the eminent metallurgist, Mr. A. Arents, and forthwith proceeded to erect several large furnaces according to the latest European models. The furnaces most favorably regarded were known as the Piltz and the Raschette. These two styles of furnaces had each in view the smelting of much larger quantities of ore in twenty-four hours than had been heretofore possible with the furnaces of the old construction. The only radical difference between the two consisted in the fact that the Piltz approached more or less nearly the cylindrical form, while the Raschette is, in horizontal section, an elongated parallelogram.

The Piltz furnace originated at Freiberg, in Saxony, and its horizontal section was octagonal; the octagon being flattened at the front or working side of the furnace. It was supplied with seven tuyeres. Plate II, Figure 1, shows a section from front to back, and Plate II, Figure 2, shows the ground plan. The upper portion was sustained by a cast-iron mantle so that the interior portion, composed of firebricks, could, when burnt out, be easily removed without disturbing the superstructure. The section of the furnace widens upwards towards the feed doors, which arrangement is exceedingly advantageous, in view of the fact that the charge becomes compacted as it descends towards the smelting zone. The gases as they ascend to the upper parts of the stack have an opportunity to expand, thus diminishing their velocity, and for this reason the amount of flue dust is very considerably lessened.

The Raschette furnace is particularly applicable to smelting both lead and copper ores, and is shown in the accompanying figures taken from the Metallhuettenhunde of Balling, published in Berlin, Prussia, in 1885. As originally constructed, it had two working fronts, and was proportionately very much longer than it was wide. Figure 1, Plate III, represents a side of the furnace; Figure 2, Plate III, represents a section through the working doors. It was found that this furnace put through in twenty-four hours from 40 to 50 per cent more ore than the round furnaces. The upper portion was, like the Piltz, supported upon an iron mantle resting upon iron columns. This furnace to-day forms the basis of construction of all the

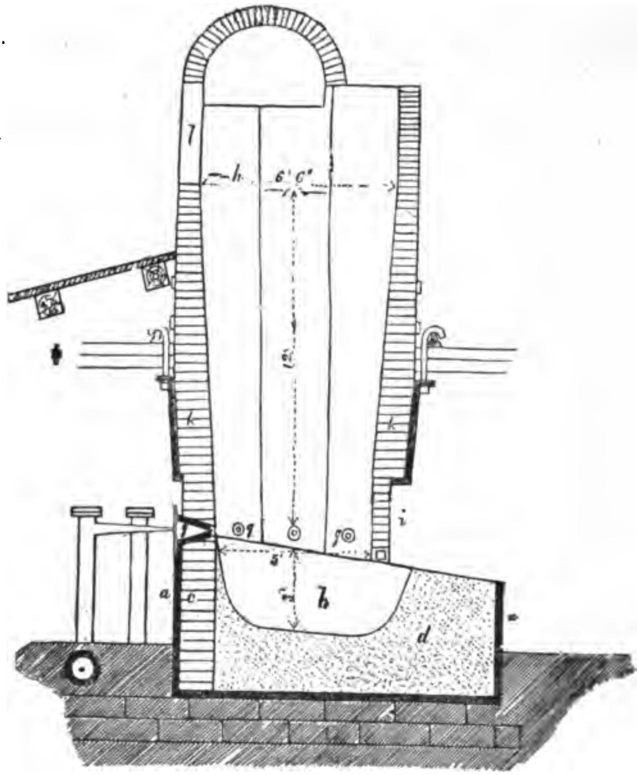


PLATE II, FIGURE 1.—SECTION.

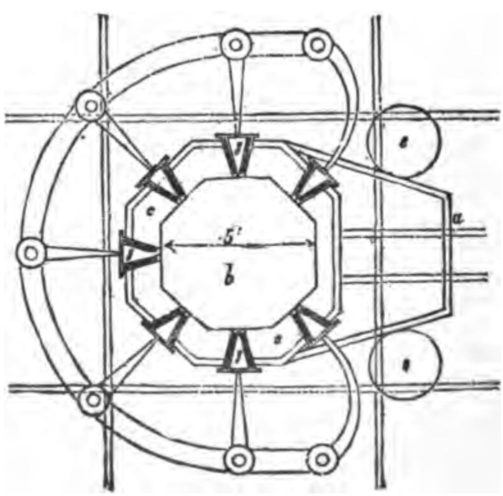


PLATE II, FIGURE 2.—PLAN.

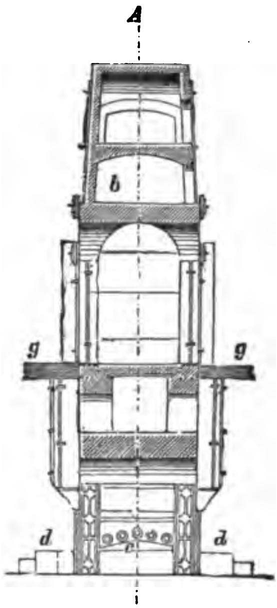


PLATE III, FIGURE 1.

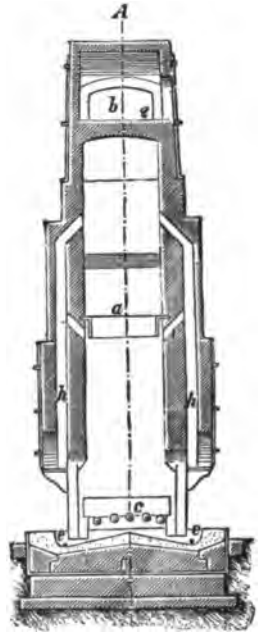


PLATE III, FIGURE 2.

more modern American smelters. As soon as Mr. Arents assumed charge as Metallurgist of the works of the Eureka Consolidated Mining Company, he sought to improve on both the Piltz and Raschette furnaces, and as a result a furnace described in the work already mentioned and pictured in the accompanying sketches was built at Eureka, Nevada.

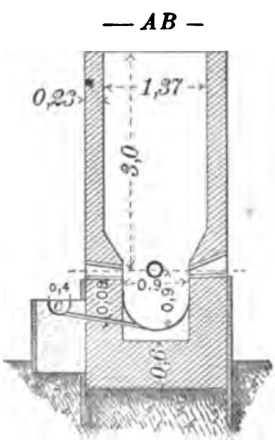


PLATE IV, FIGURE 1.

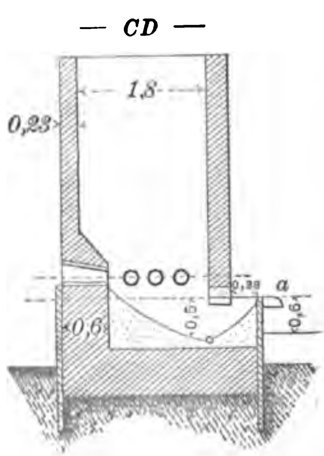


PLATE IV, FIGURE 2.

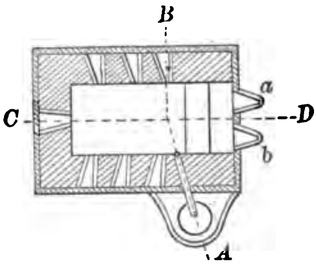


PLATE IV, FIGURE 3.

Figure 1, Plate IV, represents a section through the long sides of the furnace, and shows at the left the automatic or siphon tap, which will be further described hereafter; Figure 2, Plate IV, represents a section from the front to the rear of the furnace through the slag discharge or working door; Figure 3, Plate IV, represents a section plan at the level of the automatic tap and slag discharge. The dimensions are given in metres and fractions. One metre equals 3.2809 English feet. This furnace distinguishes itself from all others heretofore built in the following particulars, viz.: the introduction of the contracted inclined bosh, which is an eminently rational form of construction, for the reason that when the charge has become molten, and the fuel mixed therewith has fulfilled its office, the smelting material naturally becomes greatly diminished in cubical contents, and requires less space for its accommodation.

The writer would add, as an additional suggestion, that the interior walls of the furnace instead of proceeding directly upward might, with advantage, as in the Piltz furnace, expand in the form of a letter V, the lower portion being towards the hearth. In this way the gases, formed in the operation of smelting, as they ascend, having greater room, lose something of their velocity, and in so far diminish the amount of mechanical loss of fine ore or flux. Another very essential difference will be observable from the sketch, viz.: the forward rake of the tuyeres towards the hearth or slag discharge of the furnace. This construction drives the slag as formed towards its natural exit, the slag door. Further, there is observable in the plan two spouts. The one *b*, being from two to two and a half inches higher than *a*, is intended for the discharge of the slag, *a* being intended for the discharge of the matte or speiss, if either or both should be formed. In addition to this, in Figure 1, may be seen the automatic, or, as it is sometimes called, the siphon tap or lead-well of Keyes & Arents. In the sketch the tap *a* is incorrectly delineated, being drawn at too low an angle. It should be so constructed that a bar inserted from the outside will readily pass to the bottom of the furnace, an angle of 35 to 45 degrees being the most appropriate. On page 660 of Professor Emmons' twelfth volume of the United States Geological Survey, this tap is described as "one of the most important inventions ever made in the construction of smelting furnaces."

The accompanying figure, Plate V, taken from the patent granted to the inventors, shows the exterior basin and the tube connecting it with the bottom of the furnace. As originally proposed by Mr. Arents, this connection was made directly downward from the bottom of the exterior basin to a point level with the bottom of the smelting furnace, and from thence by a horizontal channel. When this device was first attached to the furnace the building took fire from incautious firing, and water having been poured

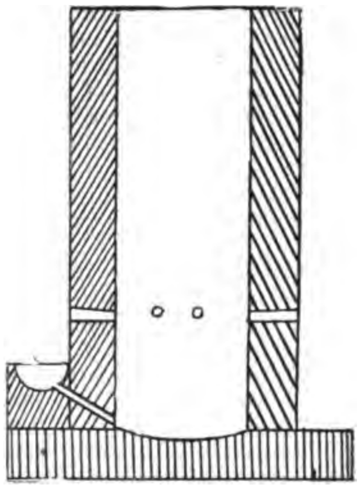


PLATE V.—KEYES & ARENTS' AUTOMATIC LEAD WELL.

upon the flames, ran down the side of the furnace and into the exterior tap basin, chilling the lead and necessitating the reconstruction of the tap basin and tap canal. Upon the suggestion of the writer, the original right-angled connection was abandoned and the connection was made at an inclined angle, and such has proved by long practice the more desirable form of application.

A patent was granted to Messrs. Keyes and Arents as joint inventors, and until the present time, when the patent has nearly expired, the inventors have had to fight from Court to Court, until at last, in the spring of 1888, a definite and final conclusion has been reached, according to the decision of Justice Miller, while on his circuit in Denver, in the State of Colorado. It might be mentioned, in passing, that no sooner was the patent obtained than the inventors were met by a claimant who assumed himself to have first planned the tap. A year or more was lost in fighting this piratical claimant before the Patent Office, in which the patentees were triumphantly vindicated and the device declared a joint invention. Some years subsequently, nearly all the great smelting works of Colorado combined in an attempt to defeat the patent. Five years were spent in this ligitation, and the Supreme Court of the United States finally sided with the patentees. The upper portion of the furnace, as originally constructed at Eureka, Nevada, was supported upon broad iron plates resting upon stout cast-iron pillars. That part of the furnace surrounding the smelting zone was made of so called "pancake" fire-rock. This rock was nothing but compact sandstone, discovered first in the coal measures at a distance of some thirty odd miles from the town of Eureka. Subsequently a similar rock was found within a mile or so of the furnaces. This rock was naturally expensive. It had to be smoothed, shaped, and placed in position, leaving holes through it for the admission of the tuyeres. After the furnaces had been in operation for some time, it was found that the expansion of the rock was so great that the upper portions of the furnace above the cast-iron pillar supports were pressed upwards, and the thick iron columns were broken off. Ultimately they were abandoned as unnecessary, the stone-masons having become so skilled that they could withdraw piece by piece the lower portion of the furnace and replace them without disturbing the

superior portion. At first the hearth of the furnace was lined with brasque, a mixture of clay and charcoal, or coke dust. Ultimately, however, this was found to be unnecessary, and rock and firebrick alone constituted the walls of the interior, as well as the bottom of the furnace hearth.

The furnaces yielded most promising results, and when they were fairly in heat succeeded in putting through in twenty-four hours as high as sixty to sixty-five tons of ore.

GENERAL REMARKS ON ORE BUYING.

By far the larger portion of ores produced in the silver lead mines of the far West are not reduced by the owners of the mines. They are sold either under contract or at public auction, on account of the mine owners. For this purpose there are public sampling works, as well as those belonging to the smelting works themselves. The ores to be sampled are, when necessary, passed through rock breakers, and if they be poor one tenth portion, or if they be richer one fifth, is comminuted. If very rich the whole of it is crushed. Three sample bottles are usually obtained. One is given to the assayer of the smelter, one to the assayer of the seller, and the third is kept in case of dispute. It is usual, when the assays agree to within, say, one ounce of silver, to divide the difference, and settle upon that basis. Payment for the ore is usually made on the day when the seller and the smelter agree upon the assays. New York quotations for silver and lead on the day of settlement are assumed as the basis of price. The ore may be delivered either at the works of the smelter, or placed free on board at the point of shipment. It is usual to take the weight and the moisture as determined by the smelter.

The charge for smelting differs in various localities, and is dependent upon the price of fuel and labor and the distance necessary to ship to a refinery. A higher smelting charge is necessarily exacted when the ores are sulphuretted or highly siliceous. Zinc, sulphate of baryta, and occasionally silica, are charged for at so much per unit in excess of a certain percentage fixed by the smelter. Commonly 50 cents a unit is charged for every per cent of zinc over 5 in sulphuretted ores, and over 10 per cent in oxidized ores. If the ores contain sulphate of baryta in excess of 10 per cent, a charge is made of 15 cents per unit of such excess. When, however, the ores are calcareous or highly charged with oxide of iron, a reduction is often made in the charge for smelting. As regards the lead, some smelters require a certain minimum, and an extra charge is made for each per cent of lead below such minimum. It is usual to deduct 5 per cent for loss of silver in ore, and calculate the value on New York quotations for the residue. When, however, the ores are dry or siliceous, a still further deduction is made; often as high as 10 per cent for one hundred-ounce ore, and less for the higher grades. The usual charge for smelting dry ores is from $12 to $16 per ton, and occasionally as high as $25. The gold contained is paid for from one tenth of an ounce per ton upwards, at the rate of $18 to $19 per ounce. As a rule, no payment is made for lead, when the assay shows less than 10 per cent. In Salt Lake the purchase price of ores is somewhat less complicated than in Colorado. Ten per cent is deducted for the loss in lead, and 5 per cent for the loss in silver, less 50 cents off the New York quotations, which is equivalent, say, to 92 per cent. Naturally, being more remote from the ultimate market, the smelting charge is higher in Salt Lake than in Colorado, and runs, according to the ore, from $3 to $25 per ton.

During the past summer the Eureka Consolidated Mining Company, and the company known as the Richmond, of Eureka, Nevada, entered into an agreement as to the price they could respectively pay for lead and other ores. According to the last published reports of the Richmond, there had been little or no profit in all the ores purchased during the year by that company, and like prudent business men they determined to increase the charge, and, as might be expected, the mine owners took exception to this procedure and commenced to ship their ores for reduction to Salt Lake. Whether or no they found this advantageous, the writer has not yet learned.

The accompanying Plate VI represents a shaft furnace with its metallic bosh or water-jacket in section from front to rear, showing five tuyeres on one side; also the blower and the downcast pipe connecting the upper part of the stack with the dust chambers in the rear of the blower. The upper portion of the furnace rests on stout iron columns. The skeleton building surrounding the same is also shown. This furnace has a hearth area* of three feet six inches by eight feet six inches, and eleven tuyeres, five on each of the long sides and one in the back wall. The nozzles of the tuyeres are four inches in diameter. They are inserted ten inches above the upper edge of the hearth plates. The height of the furnace from the center of the tuyeres to the feed door is thirteen feet; depth of the crucible below the edge of the hearth plate, twenty-six inches. In this drawing the blower (which is a Baker, size seven and one half) is represented immediately in the rear of the furnace. It is better, however, to place the blower or blowers, as many as may be required, in the engine room, not in the furnace room proper. With the latter arrangement the blower is immediately under the eye of the engineer, and there is less danger of explosion from back blast, destroying the blower, as the writer has sometimes observed in his own practice. Further, if the belt should slip the engineer can the more readily observe it. It has also the advantage that the blower or blowers are not exposed to the dust always present more or less in and about the furnace building; and further, a long line of shafting is rendered unnecessary. When the blower is so placed, it is desirable that the supply of air for the blast should be drawn through a brick conduit connecting with the outer air, because if such be not done, the revolutions of the blower cause a disagreeable vibration of air in the engine room and much clattering of windows and other light materials.

If there be more than one furnace, it is preferable to connect as many blowers as may be required with a general supply pipe and draw from it the amount of air required for each furnace. The main supply pipe should have an end valve and safety-valves at the proper distances. A No. 7½ Baker blower requires thirty-five-horse power to drive it. It will be observed from this drawing that the flue descends to the dust chambers from a point in the stack above the charging doors. Some smelters, and notably those of the Omaha and Grant Companies, draw off the smoke and dust below the feed door, in a manner similar to that in use at Freiberg, in Saxony. The same method is in vogue at the Richmond and Eureka Consolidated Works, in Eureka, Nevada; at the Horn Silver, Hananer, and Germania Works, at Salt Lake City, Utah; at the Harrison Reduction Works, American, Manville, and Arkansas Valley Works, at Leadville, Colorado; at the Colorado Smelting Works and Pueblo Smelting and Reduction Company's Works, at Pueblo, Colorado. Each has its

*It would perhaps be well to alter the internal section of the furnace to three feet by ten feet, instead of the dimensions here given.

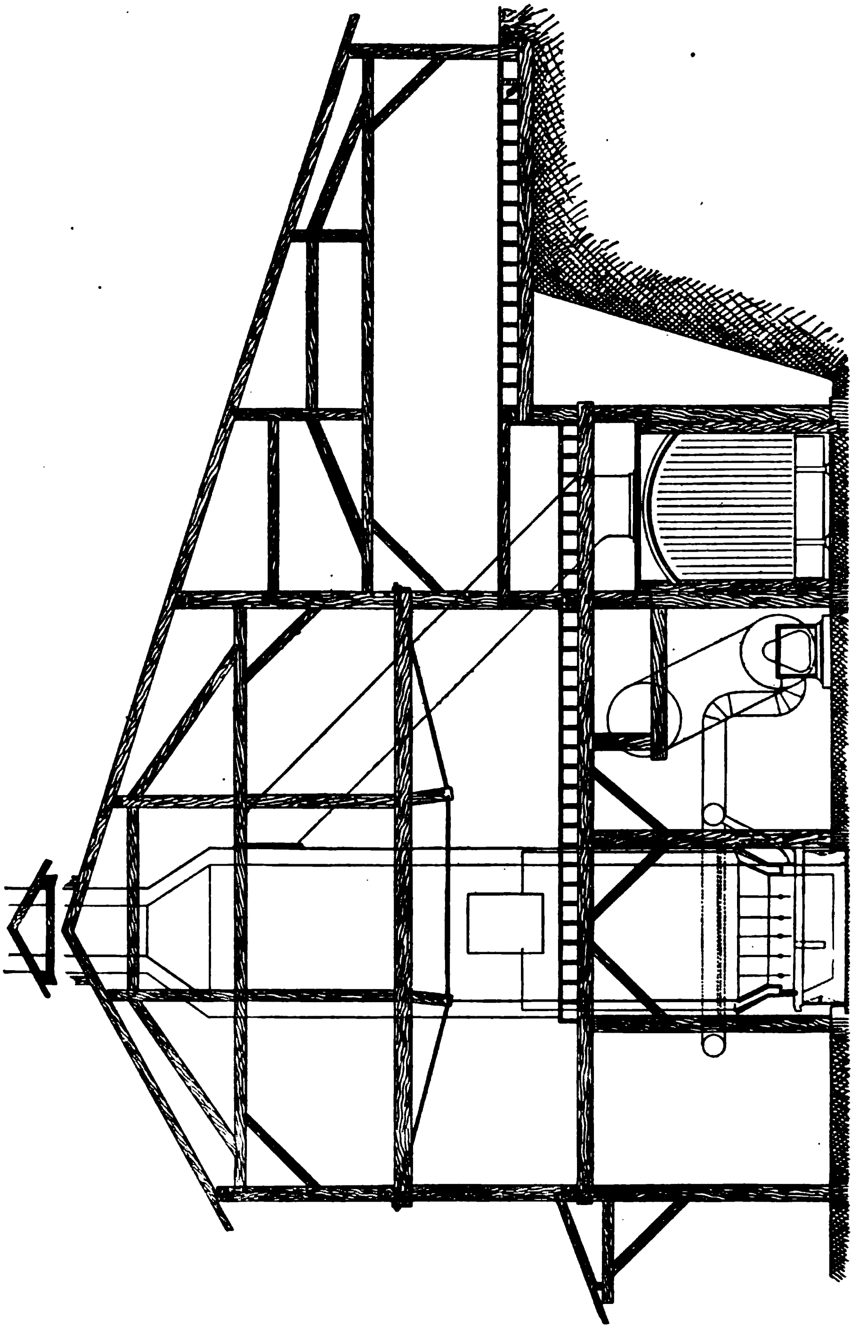


Plate VI—A Typical Modern Furnace.

advantage and disadvantage. If the former method be used it is necessary to have a high superstructure in order to allow for a proper declination of the downcast pipe. With the second method the furnace is apt to occasionally flame at the throat, and in no case can the stack be filled up with smelting material higher than the lower edge of the flue connecting with the dust chamber.

The writer, in 1872, observed at the Chicago Smelter, near Stockton, Utah, what seemed to him a very practical method for saving flue dust and condensing the metal vaporized. The apparatus there used consisted of a moderately large Cagniardelle, such as was formerly used in Germany for furnishing blast to smelting furnaces. This Cagniardelle is formed by a large sheet-iron cylinder, set in a tank partially filled with water, attached to an inclined axis, and having a spiral diaphragm inside from one end to the other. In appearance it closely resembles a wide-mouth conch shell. When used in Germany for a blast, it gathered in a large mouthful, so to speak, of air, and as the cylinder revolved the air was forced down beneath the surface of the water to the lower end, whence it was led off in pipes to the smelting furnaces. When used, however, as a condenser, the Cagniardelle gathers in the smoke, dust, and fumes from the smelting furnace, forces them down through the water, wherein they are precipitated in the bottom of the tank, from whence they may be withdrawn from time to time. The practical working of this device at the furnace near Stockton, Utah, appeared to be entirely satisfactory, and no smoke could be seen issuing from the top of the connecting chimney.

THE MANNER OF CALCULATING THE VALUE OF ORE.

In order that the smelter may arrive at an intelligent valuation of the ores offered to him for purchase, it is necessary to know what is the cost of freighting to a refinery, refining charges, commissions, etc., in addition to the cost of fuel and labor. If now, for example, the refinery charges be $9 per ton, there must first be deducted 5 per cent for loss of lead, and three ounces for loss of silver, per ton. If, now, we assume the freight to be, say from Eureka, Nevada, to Newark, New Jersey, $37 50 per ton, we can approximate the value which the smelter may place upon the proposed purchase. If, for example, we have an ore assaying, say, 36 per cent of lead, and the New York quotation of lead be $4 50 per hundred pounds, one ton of ore will contain seven hundred and twenty pounds of lead. Assuming that the loss in smelting be 5 per cent, we shall obtain in work lead seven hundred and twenty pounds, less 5 per cent, equals 720, minus 36=684 pounds. Deducting again 5 per cent for loss in refining, we have, therefore, 684 less 5 per cent equals 684 minus 34=650. The value of 650 pounds of lead in New York is 650×90÷2,000=$29 25.

Commission in New York on one ton of lead at ½ of 1 per cent	$0 45
Transportation from Newark to New York	1 00
Freight to New York	37 50
Refining charges	9 00
Total	$47 95

Therefore, the amount chargeable to the 684 pounds of base bullion would be 684×$29 25÷2,000=$16 40. Hence, $29 25 minus $16 40=$12 85. Dividing this figure by the original 720 pounds of lead, as shown by the assay, we obtain as a result a value of 1.784 cents per pound; and since 20 pounds is equal to one unit, we have a value per unit, say in Eureka, of 1.784 cents×20=35.68 cents. If, now, the smelter should pay 25 cents per unit for the lead, we have 25 cents×36=$9. And $12 85

minus $9=$3 85, profit on the lead contained in one ton of this 36-per cent ore. In fact, an ore so high in lead would be considered a very desirable one at present, especially in Colorado.

If, now, the ore should run twenty ounces of silver per ton, and deducting 5 per cent loss in smelting, we should have a total of nineteen and a half ounces, worth at New York quotations say 92 cents per ounce, or $17 94 per ton. Adding together the figures $3 85 and $17 94 we have a total of $21 79 as the gross value of the ore, and from this deducting the smelting charge there remains the price which the smelter can pay for the ore in question. So great, however, has been the competition in the purchase of ores both in Salt Lake and in Colorado, and so keen the emulation of the purchasers to obtain sufficient ore to run their furnaces, that the net profit has, in many instances, been reduced to a minimum, or has actually disappeared. During the last summer, according to the public prints, all but one of the furnaces in Salt Lake have ceased active operation. The great furnaces in Colorado, having a large capital and extensive plant, have been content to work with so small a margin of profit that the smaller companies have been driven to the wall and in many instances have permanently gone out of blast.

TREATMENT OF THE BASE BULLION.

Most of the American refining works use for the separation of the precious metals from the lead some modification of the Parke's zinc process. At the works of the Richmond Mining Company at Eureka, Nevada, however, the Rozau steam process is used. As a rule before subjecting the base bullion to treatment for the extraction of the precious metals, it must be calcined, which is done in large iron pans. By the Rozau process a jet of steam is conducted into large kettles containing the molten lead, which causes a violent and continued ebullition of the whole mass. Toward the end of the operation, and while the same is still active, the lead is found to be nearly freed from the copper which it contained. The antimony, etc., is gradually oxidized as it comes in contact with the air. The lead is run off when about two thirds is in the form of crystals, and the operation is repeated until there remains enriched lead and merchant lead. The former is sent to the cupel hearth, and the latter, after melting and running into bars, is ready for market.

FUEL.

The fuel used in all blast furnaces is either charcoal or coke, or both. The best wood for charcoal is the piñon pine, and the best cokes are the English and those from Connellsville, Pennsylvania. The cost of charcoal is different in different localities, and varies from ten to thirty cents per bushel. The coke varies also in price, according to the price of freight. The English coke is worth about $14 50 per ton in San Francisco, and its price to the smelter is this figure plus the cost of transportation to his furnace. Of late years the Trinidad and Crested Butte coke, of Colorado, have obtained extensive use in Colorado and elsewhere. Where possible, it is desirable to use a mixture of both coke and charcoal. The consumption of mixed fuel amounts to from 14 to 24 per cent of the weight of the smelting mixture, and this expenditure is largely dependent upon the season of the year and altitude of the furnace plant; the lower figure corresponding to the summer and the higher to the winter season. When charcoal alone is used, the percentage of fuel reaches or even exceeds the highest figure given above. Charcoal wastes considerably every time it is moved, and this in a measure applies to coke; hence an allowance must

be made therefor. In Eureka, Nevada, it was usual to allow for this waste about 12½ per cent of the fuel purchased.

FURNACE PRODUCTS.

First—Silver lead, called by the Germans work lead, and by the Western mine smelters base bullion. As a rule, this base bullion is shipped and sold to a refinery. In some instances, however, the base bullion is refined upon the spot.

Second—Speiss, a combination of arsenic or antimony and metallic iron. This material usually contains a sufficient amount of precious metal to render its extraction desirable, if the economic conditions be favorable; and such extraction is now, and has been for some time, practiced at the refining works at Eureka, Nevada.

Third—Matte, consisting chiefly of a combination of sulphur and iron. This material also usually contains some lead, and more or less gold and silver. It is, as has been heretofore stated, set aside to be reroasted and resmelted; and if there be copper in the matte, the latter metal becomes concentrated by such continued retreatment, and the copper is finally obtained therefrom.

Fourth—Slag, which is partly a chemical and partly a mechanical mixture of the melted gangue and waste matters contained in the ore and fluxes. That which first issues from the furnace is richer than the average slag produced, and is set aside and resmelted. A slag is considered satisfactory when its tenor in silver is less than one ounce and 1 per cent of lead per ton.

Fifth—Flue dust. This material consists chiefly of the finer particles of ore and fuel, forced out by means of the blast. In amount it may be estimated at about 2½ to 3 per cent of the dry ore put into the furnace. Occasionally the loss in flue dust is much more. Various forms of apparatus have been constructed and utilized for regaining this material. It is at all times a troublesome substance to retreat. Dampening it does but little good, and is at best but a temporary expedient. A better procedure is to mold it into brick form with milk of lime; or, better still, if such is obtainable at a moderate price, to bind it together with a solution of sulphate of iron. When thus compacted it may be added to the charge and treated as ore.

Sixth—and lastly. The wall accretions, dross, and sweepings about the furnace.

*DE-SILVERIZATION OF THE SPEISS AT THE EUREKA CONSOLIDATED WORKS AT EUREKA, NEVADA.

An analysis of an average sample of this material is as follows:

	Per Cent.
As	32.950
Sb	.130
Mb	2.310
S	3.340
Pb	2.180
Cu	1.060
Fe	57.020
Zn	.070
CaO	.340
SiO2	.230
Au and Ag	.029
Total	99.659

*See article T, Rickards' B. S., in the "New York Engineer and Mining Journal," June 30, 1888.

Assay.

Silver	$8.01 per ton.
Gold	.43 per ton.

The first practical attempt to utilize the speiss was at the works of the Richmond in Eureka, and consisted in tapping the molten speiss into pots having a lining of clay and limestone, and at the same time adding a sufficiency of lead or lithage to collect the precious metals contained therein. The carbonic acid set free by the heat of the molten speiss serves to keep the contents of the pot in ebullition, so that the lead gradually sinks to the bottom of the vessel, carrying the precious metals with it. As a result, there was extracted about 67 per cent of the value contained therein. This process was improved upon by Mr. L. W. Davies, head smelter at the works of the Eureka Consolidated Company, and consists in the main in adding about 25 per cent of molten lead to the molten speiss, in a metal converter under an air pressure of seventeen pounds. This converter is cylindrical and has a lining of two and one half inches of firebrick. The economic results hereby obtained have been quite favorable. The percentage of silver extracted is reported at 83.50, and of gold 89.28 per cent.

FLUXES AND FLUX.

Since very few ores are made up of gangue in such relative proportions as to be self-fluxing, it is necessary to supply or make up the missing ingredients. The fluxes most commonly required are: First, quartz, or some other siliceous material, as sandstone or sand; second, iron ore; and third, limestone. And as these fluxes themselves are seldom or never pure, it is necessary also to make allowance for the impurity or impurities contained in each of the several fluxing materials; hence, all the fluxing materials, as well as the fuel, must be carefully analyzed.

LOSS IN SMELTING.

Every metallurgical process gives rise to a greater or less percentage of loss in each operation. A loss ensues when, owing to the presence of an excess of sulphur, arsenic, or antimony, roasting is necessary. A further loss ensues through the smelting itself, part of the precious and useful metals being entangled in the slag; and a still further loss takes place when the base bullion is refined. As a rule the loss in smelting proper may be put down at from 3 to 4 per cent of the silver, and of variable amounts of lead, depending chiefly upon the poverty or richness of the ore in this metal. The loss of lead varies under circumstances from 5 to as high as 15 per cent.

THE COST OF SMELTING.

This is as variable as the situations of the various works, and is dependent, firstly, upon the price for labor and fuel, and, secondly, the freight charges for the bullion to market, refining, etc.

Under *the most favorable conditions* both as to ore, fluxes, fuel, and labor, the most docile lead ores may be smelted as low as $3 or $4 per dry ton. Under unfavorable conditions the cost of smelting may run as high as $18 or $20.

Nearly all the principal smelting works of the country have what they denominate an open or public tariff of charges, which is freely furnished on application. This represents their maximum charges. Economic con-

ditions naturally vary from time to time and, an ore may, under circumstances, be worth more than the smelter is willing to admit to his business rivals. The mine owner generally receives this advantage whenever such a contingency arises.

SLAG ASSAYS.

Every morning and every afternoon it is desirable, not to say imperative, that a sample should be taken of the slag produced in the preceding twelve hours. The proper time to take these samples is after the tapping of the first pot of slag, for the reason that the first slag withdrawn is apt to be richer in both lead and silver than the average slag produced by the furnace. The method of procedure is a modification of the so called fluth hafter (tailing) assay used by Kerl. Ten grammes of slag finely pulverized are mixed with one teaspoonful of flux and five hundred milligrammes of fine silver in a five gramme (A_2) Battersea crucible covered with one and a half grammes of borax-glass and fused in a muffle furnace. The flux so used consists of an intimate mixture of—

Sixteen parts by weight of carbonate of potash.
Sixteen parts by weight of bicarbonate of soda.
Six parts by weight of argol.
Four parts by weight of borax-glass.

After a proper fusion the weight of the silver is deducted and the difference represents the lead contained in the slag, and its percentage may be readily calculated.

A basic slag requires also the addition of a proper amount of pulverized bottle glass free from lead. An acid one, on the contrary, requires the addition of a proper amount of bicarbonate of soda.

ASSAY OF THE SLAG FOR SILVER.

Mix one half assay ton of slag with one and one half teaspoonfuls of flux, and twelve grammes of granulated Swansea test lead, covered with one and one half grammes of borax-glass, and fuse in a muffle furnace. The resulting button, when cupelled, will give the amount of silver contained in the slag. One of the objects of taking slag assays both morning and evening is to enable the head smelter to form some judgment as to the carefulness or negligence of the workmen throughout the entire shift.

Should the assay prove high when the smelting charge is known to have been correct, it affords fair presumptive evidence of negligence on the part of the furnace tenders. When, however, ores rich in zinc have been smelted, the slags produced contain an unusual amount of both lead and silver, owing to the scattered particles of matte entangled in the slag. In this case all such slags should be set aside, and put through the furnace a second time. Naturally this entails additional expense, and the smelter must be the judge as to the economic advantage or disadvantage of re-treatment.

ROASTING.

Such ores as contain an excess of 5 per cent of sulphur require roasting. It is only of late years that any considerable proportion of the ores offered for sale have needed this preliminary treatment. The roasting is usually performed in reverberatories, in length from thirty to forty feet, and in width from ten to twelve feet, and divided into three or more floors. The time of roasting is variable, dependent upon the amount of sulphur

in the ore, bulk of the charge, quality of the fuel, etc. The roasting lasts from a half hour to thirty-six hours, and should be continued, as a rule, until the sulphur has been so far eliminated as to leave no more than 5 per cent. In making an estimate for the sulphur left in the ore after roasting, the sulphuric acid combined in forming the sulphates must likewise be taken into consideration. The sulphur left in the roasted ore must have sufficient metallic iron in the charge to combine therewith to the formation of matte. If such iron be not present in the ore itself, it must be supplied from other sources. The matte resulting must be re-roasted and re-smelted. Antimony and arsenic in the process of roasting are in part volatilized and in part oxidized to the formation of arseniates and antimoniates. These, when exposed to the reducing gases of the furnace, return to the condition of arsenic and antimony metals, giving rise to the formation of speiss.

TOOLS AND OTHER IMPLEMENTS REQUIRED AT AND ABOUT A BLAST FURNACE IN LEAD SMELTING.

For the Feeder.

Two D-handled steel scoopshovels, size 8, wide mouthed. The shovel proper is fourteen inches in width by sixteen inches in length.

Two square-pointed long-handled steel shovels, size 3.

Two napping hammers, No. 8, weight six pounds; for breaking up coke, slag, etc.

One three quarter-inch rod of wrought-iron with bail for loosening up the ore.

One ten-pound double-faced striking hammer, No. 52.

Two bars one and one half-inch octagonal machinery steel, ten feet long.

Two bars one and one half-inch octagonal machinery steel, eleven feet long.

Two bars one and one half-inch octagonal machinery steel, twelve feet long.

Sundry gads, eighteen inches long, of one and one quarter-inch steel, and a number of stiff brooms.

For the Weigher.

One scale, one thousand pounds capacity, with a platform thirty by forty-two inches.

One one-wheel E barrow, for weighing up charges.

One long-handled steel shovel, size No. 4.

One scraper, to clean the scale platform.

A number of coarse brooms.

For the Coal Passers.

One coke buggy, holding about five hundred pounds of coke.

One large wheelbarrow, for charcoal.

Two fourteen-tine steel coke forks.

One No. 8 scoopshovel.

For the Ore Wheelers.

Two ore cars of twelve cubic feet capacity.

One D-handle shovel, size 4, and a number of picks and brooms.

For the Furnace Floor.

Thirteen slag pots, twenty-three inches in diameter, for a sixty-ton furnace. See accompanying Plate VII, showing one model with details, and Plate VIII, Figures 1 and 2, showing a second model with details.

Two matte or speiss pots, if such be necessary. See accompanying Plate IX, Figures 1 and 2.

One one-inch octagonal steel bar, five feet long.

Two three quarter-inch octagonal steel bars, four and one half to five feet long.

One five eighth-inch octagonal steel bar, four feet long, for tapping, when necessary.

All these bars must have diamond points and large heads. It is well also to have a number of "claws" made of Norway iron, to assist in withdrawing the bars if any of them should become stuck inside the furnace.

One ten-pound double-faced striking hammer, No. 52.

One four and one half-pound double-faced hand drilling hammer.

Two three eighth-inch rods of iron, six to seven feet long.

One three fourth-inch rod of iron, twelve feet long.

One three fourth-inch rod of iron, eight feet long.

One tuyere poker, three fourth-inch round iron, four and one half feet long.

Two scrapers, one fourth by two inches flat iron, twenty inches long.

One tamping iron, having a face of two inches by one half an inch, and one inch in thickness, and a handle eighteen inches long.

Three tamping rods for plugging up slag hole, about eight feet long, with buttons on one end about two inches in diameter.

Ten bullion molds, each holding one hundred pounds of metal.

One trimming chisel, five eighth-inch octagonal steel, with a face of one and one half inches.

One skimmer for skimming the bullion in the cooler, provided such be used.

One small skimmer for cleaning the surface of the metal in the automatic tap.

One bullet ladle for taking slag samples.

A number of bullion ladles made of one fourth or three sixteenth-inch charcoal iron, eight and three fourth inches in diameter and three and one half inches in depth, to which is attached a gas pipe handle two feet ten inches in length, turned so as to form a proper hand grip. The handle must be securely riveted to the bowl.

In blowing out the furnace there will be required two long bars, one and one half-inch octagonal steel, twelve feet in length.

Sundry shorter bars, drill pointed.

Two rabbles, seven and one half-inch by six-inch face, securely riveted to eight-foot handles with a proper hand grip.

Two goat-foot hooks for withdrawing lumps or accretions.

Two perforated ladles, fourteen-inch by twelve-inch face, with eight-foot handles of seven eighth-inch diameter, and proper hand grip, to clean out the metal in the crucible.

Lamps and lanterns.

For the base bullion sampler there is required—

One punch of seven eighth-inch octagonal steel.

One cold chisel.

One set three fourth-inch figures.

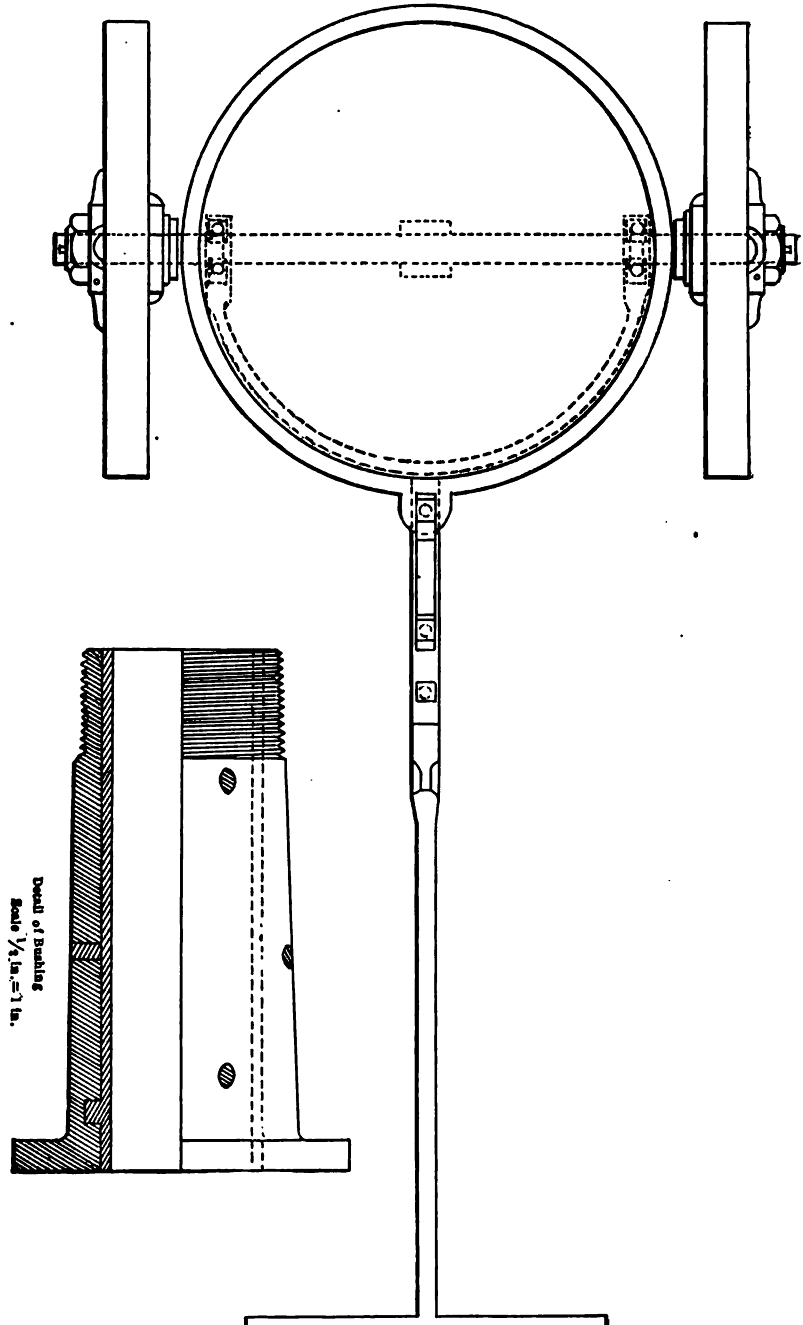


PLATE VIII, FIGURE 1.

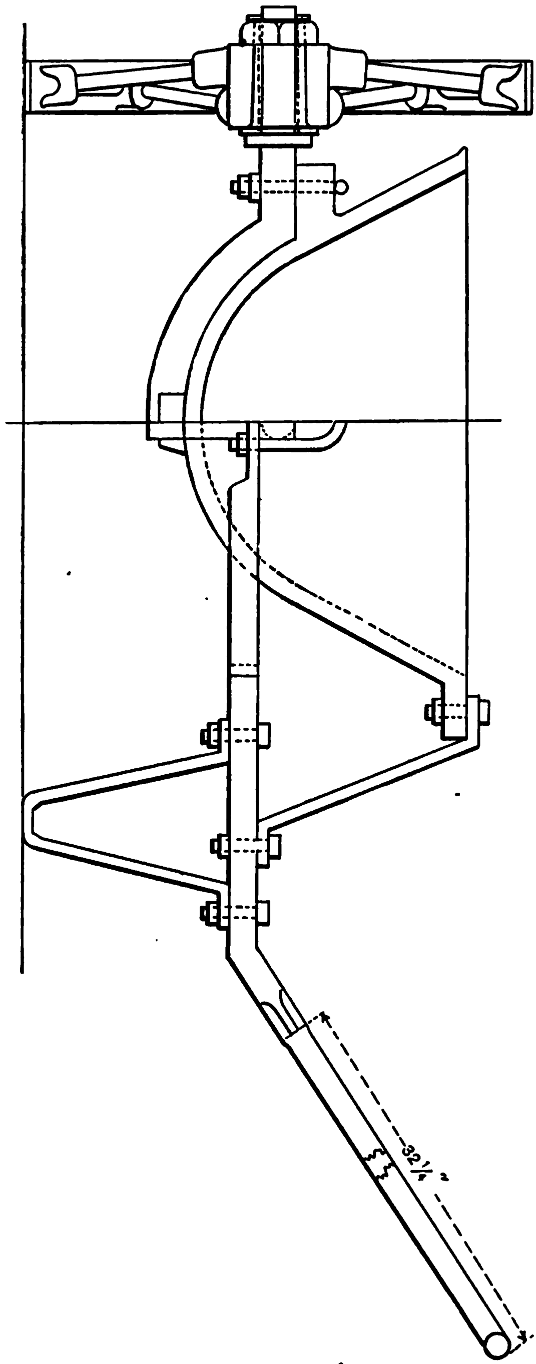


PLATE VIII, FIGURE 2.

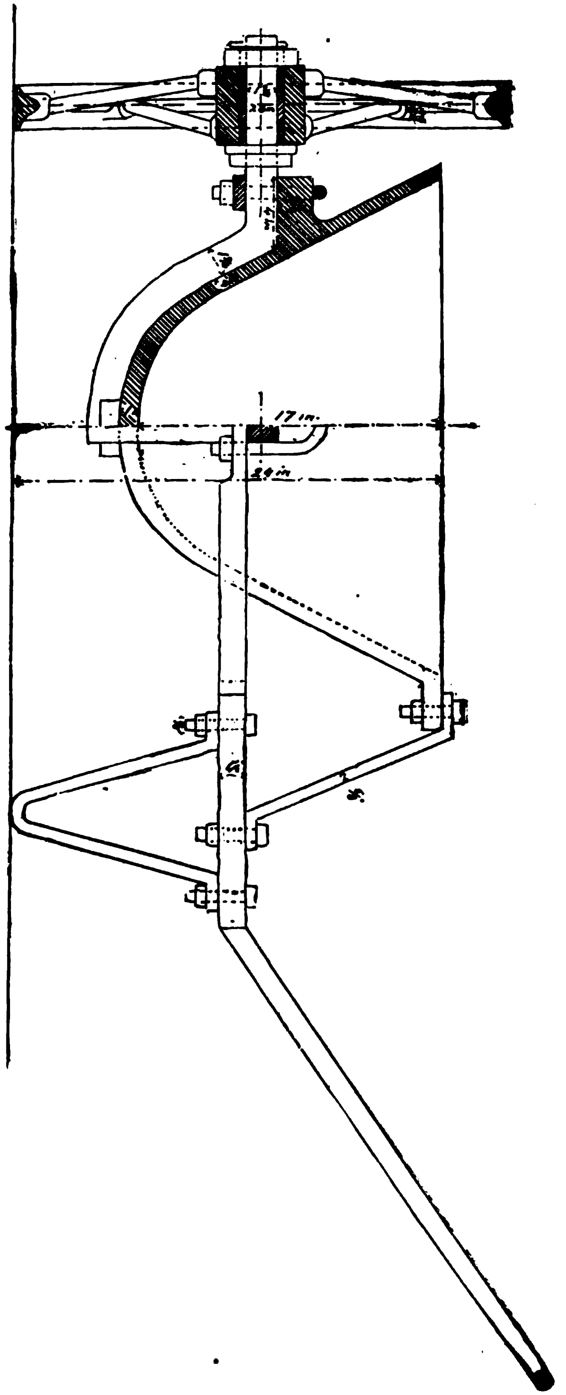


PLATE IX, FIGURE 1.—MATTE OR OVERFLOW POT.

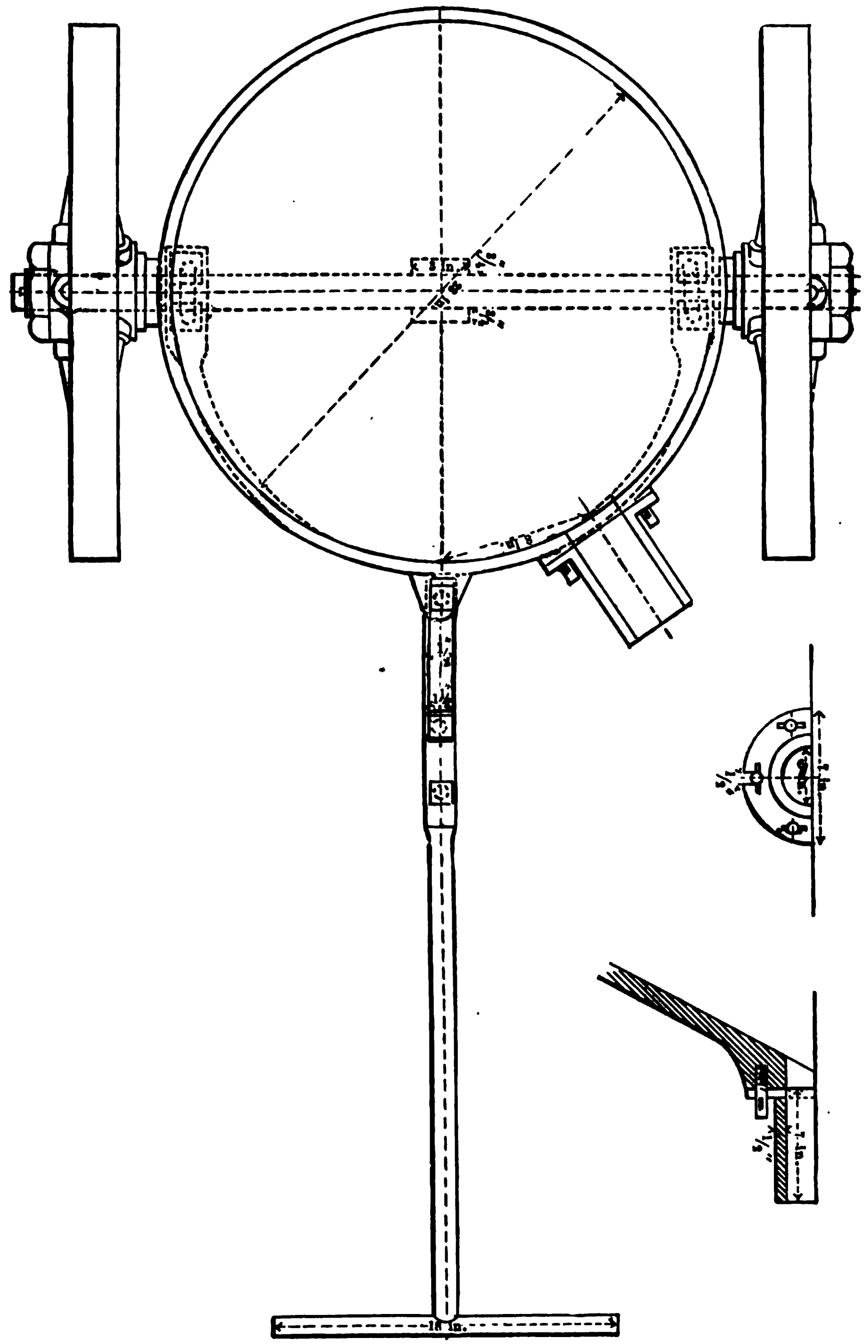


Plate IX, Figure 2.—Matte or Overflow Pot.

BULLION.

The bullion produced is placed upon a truck, holding say twenty bars, and drawn or pushed over a railroad to a platform scale with a double beam, and a capacity of two thousand pounds. The bullion bars are sampled by driving a bullion punch half way into the bar on each side. Four bars are laid closely side by side. A sample is taken diagonally across the bars; the bars are then turned over and a sample is taken diagonally on the opposite side and in the opposite direction. Three hundred bars constitute a carload; hence we have six hundred samples. The bullion chips thus taken are for each bar, two and one half inches long and three sixteenths of an inch thick. They would together weigh something near nine pounds. They are melted in a No. 8 black lead crucible, and poured into a mold eight inches long and two and one fourth inches wide. From this bar the chips are taken for assay.

PREPARATION OF THE ORE FOR SMELTING.

The usual plan for preparing the smelting mixture is to lay down a large number of tons together with the proper fluxes, and to weigh out the charges at the feed door. If deemed more convenient, and especially where the ores are of a different size and different character, it may be better to have the feeder weigh out directly the charge, or half charge of ore and fluxes, just before putting them into the furnace. This requires more labor, it is true, but is often sufficiently advantageous to warrant the increased expense.

All ores are either acid, basic, or neutral. The last so seldom that it may be left out of account. The principal constituents to be regarded in the matter of preparing admixtures for the formation of a proper slag are, first, silica, representing the acid; and second, iron, lime, magnesia, and the alkalies. Alumina is sometimes present and acts either as a base or as an acid. It is usually considered as equivalent to silica and reckoned as such. Magnesia and baryta when present are reduced to lime in the ratio of their molecular weights, and entered in the calculations as calcium oxide. The alkalies being usually in such small proportion, may be disregarded or allowed for amongst the bases. Naturally, in order to calculate the constituents of a slag at all, it is necessary to have a full and complete analysis both of the ore and of the fluxes. This is practical chemistry in its highest development, and should not, therefore, be intrusted to ignorant furnace operators. The writer is well aware of the unreasoning prejudice often existing against so called men of science, but science is nothing more than knowledge, and is the crystallization of the results and practices of other men. Knowing the composition of both the ores and fluxes, the head smelter can proceed to the combination of a slag which will meet, not only the metallurgical, but the economical conditions of his locality. The principal slags are the following:

First—Sub-silicates, where the oxygen of the base is to the oxygen of the silica, the acid, as two to one. The chemical formula being $4\ Ro\ SiO_2$.

Second—Singulo-silicates, in which the oxygen of the base is to the oxygen of the acid, the silica, as one to one. The chemical formula being $2\ Ro,\ SiO_2$.

Third—Bi-silicates, in which the oxygen of the base is to the oxygen of the silica, the acid, as one to two. The chemical formula being $Ro\ SiO_2$.

In practice these slags are mingled both mechanically and chemically in various proportions, and of such admixtures we may mention five of the more common occurrence.

First—One mono-silicate of iron plus five bi-silicates of lime, having a chemical formula as follows:

$(2\ FeO, SiO_2)+5(CaO\ SiO_2)$.

Giving a percentage as follows:

SiO_2	45.9	or nearly	46 per cent.
FeO	18.3	or nearly	18 per cent.
CaO	35.7	or nearly	36 per cent.
Total	99.9	or nearly	100 per cent.

The ratio between the protoxide of iron and the calcium oxide being as two to one, it may be called a two to one slag, or more concisely, a one half to one slag. Such a composition is advisable when iron is scarce and siliceous ore plentiful.

Second—One mono-silicate of iron, one bi-silicate of iron, with two mono-silicates of lime, having a chemical formula as follows:

$$\left.\begin{matrix}2\ FeO, SiO_2\\ FeO\ SiO_2\end{matrix}\right\} + 2(2\ CaO, SiO_2).$$

Its percentage would be—

SiO_2	35.28
FeO	31.28
CaO	32.94
Total	99.50

The ratio of iron oxide and calcium oxide being approximately one to one, this slag may be designated a one to one slag.

Third—One mono-silicate of iron plus one mono-silicate of lime, having a chemical formula of $2\ FeO, SiO_2+2\ CaO, SiO_2$. The percentage of which is the following:

SiO_2	31.91
FeO	38.30
CaO	29.73
Total	99.94

The proportion between iron protoxide and calcium oxide being approximately as four to three, this slag is known as a three fourths slag.

Fourth—One mono-silicate of iron, one bi-silicate of iron, and one mono-silicate of lime, having the chemical formula of—

$$\left.\begin{matrix}2\ FeO, SiO_2\\ FeO\ SiO_2\end{matrix}\right\} + 2\ CaO, SiO_2.$$

The percentage of which is the following:

SiO_2	35.43
FeO	42.52
CaO	22.05
Total	100.00

The ratio between iron protoxide and calcium oxide being approximately one to one half, this slag may be designated a one-half slag, and is, as a rule, the best type for the common run of ores.

Fifth—Three bi-silicate of iron, one bi-silicate of lime, plus three mono-silicate of iron and one mono-silicate of lime. The chemical formula for which is as follows:

$3\ FeO\ SiO_2\quad CaO\ SiO_2+3\ (2\ FeO, SiO_2)\quad 2\ CaO, SiO_2$.

The percentage of which is the following:

SiO_2	37.03
FeO	50.00
CaO	12.96
Total	99.99

The relation between the iron protoxide and the calcium oxide being approximately four to one, it is called a quarter slag. This slag was first extensively used by Mr. A. Eilers, and is particularly to be commended when the ore is of a highly ferruginous nature, as it requires little quartz and lime. It is also particularly adapted for use when zinc-bearing ores are to be reduced. In all these slags some allowance has to be made for the alkalies. It is scarcely worth while here to go into these minor details. The above are naturally only a few of the possible, probable, or occasional types of slag formation. All the above, however, show, on cooling, a clear and distinct crystallization.

It may be observed that slags rich in lime will carry and neutralize a greater percentage of silica than those of iron, without taking up too much oxide of lead. It should also be remembered that basic slags cause overfire or flaming at the throat, and have a tendency to corrode the brick work of the furnace, and are apt to cause considerable loss of metal owing to the rapidity and ease of their formation. A too acid slag, on the contrary, retards the fusibility of the furnace mixtures, and hence the furnace runs too slow.

In charging a furnace, the ore and fluxes may be thrown over against the side and black walls, or spread more or less evenly over the furnace. Each furnace worker has his own opinion in this regard.

Where the furnace appears to run irregularly—assuming that the fluxing mixture is correct—there are two methods of proceeding: either to diminish the charge of the ore and the flux, leaving the fuel stationary, or to leave the ore and the flux stationary, and change the amount of fuel. The latter is preferable. Slags from previous smeltings may be or may not be added to the smelting mixture. As a rule, the addition of slag is very beneficial, especially where the charge contains more or less ore in a state of great comminution or subdivision.

The ore, as received by the smelter, and placed upon the floor, of course contains moisture, and in calculating the charge it is necessary to bear this in mind, and to make the proper modification, for the reason that the ore and flux analysis is based upon a steam-dried material. It is further to be observed that 31.05 (Fe) requires 34 silica (SiO_2) for its neutralization, and further that 16 sulphur requires 28 metallic iron. When baryta or magnesia are present, either in the ore or flux, they must be reduced to the basis of calcium oxide, and as such enter into the computation. In order to do this the per cent of (BaO) must be multiplied by .3663, and the percentage amount of magnesia (MgO) must be multiplied by 1.4. Having now the analysis not only of the ore, but of the flux and fuel, the metallurgist can proceed to calculate the percentages required either to supply what is lacking in the ore, or to render harmless an excess of acid or sulphur. It now becomes simply a question of mathematical proportion.

As to the amounts of lead and silver in the respective charges, the smelter must be governed by circumstances and his practical experience. About one hundred ounces of silver to the ton of lead appears to be the most desirable proportion to "cover" the silver and thus prevent loss.

ANALYSES OF SLAGS.

In response to a circular invitation from the Mining Bureau quite a number of furnace products, slags, speiss, etc., have been received, analyzed by Mr. C. A. Ogden, Metallurgist and Assistant Chemist, and added to the collection in the museum.

The responses from Colorado and Utah were prompt and to the point.

The smelting works of California and Nevada were conspicuous by their absence. Amongst the number analyzed, showing the results of practical working on a large scale, we may take the following:

	No. I.	No. II.	No. III.	No. IV.	No. V.
SiO_2	38.30	39.37	33.27	40.01	29.01
FeO	30.88	30.44	33.65	32.12	39.61
Al_2O_3	.65	.55	.27	.31	3.46
MnO	1.35	1.89	1.53	.65	.90
CaO	21.77	21.58	23.80	22.04	18.63
MgO	2.13	2.23	2.16	1.04	2.88
S	.26	.35	.37	.47	.75
Pb	.37	.55	.58	.65	.58
ZnO	3.46	3.44	3.56	2.68	3.90
CuO	-------	-------	-------	-------	.21
	99.17	100.40	99.19	99.97	99.93

Wall Accretions.

	No. I.	No. II.
SiO_2	10.65	7.03
Fe	8.62	8.24
CaO	2.07	1.96
MgO	.34	.30
S	29.06	24.87
Pb	2.41	10.66
Zn	46.75	46.43
As	.19	.31
	100.09	99.80

Speiss.

SiO_2	4.02
Fe	50.11
Mn	1.81
CaO	1.21
MgO	.15
S	8.15
Pb	3.14
Zn	1.38
As	24.17
Sb	1.86
Cu	4.26
	100.26

THE RUSSELL PROCESS.

[Contributed.]

"The extraction of silver by the lixiviation process from ores which have been subjected to a chloridizing roasting, is based upon the fact that silver chloride is easily soluble in solutions of sodium or calcium hyposulphite, and that silver is precipitated from such solutions by an alkaline sulphide, with regeneration of the hyposulphite salts. In case the ore contains lead, a portion of the latter is also dissolved, lead sulphate being soluble in hyposulphite solutions. If, at the same time, copper is present in the roasted ore in the form of cuprous chloride, the sulphides precipitated from the lixiviation solution contain silver, copper, and lead. From gold-bearing silver ores gold is obtained together with the silver, but the percentage of its extraction varies, and depends upon many circumstances.

"Although lixiviation is much cheaper than amalgamation both as to cost of plant and working expense per ton of ore, there were many reasons why its adoption made slow progress. Leaving out the fact that there always exists a prejudice against any new method that requires more skill and chemical knowledge than those in vogue, the lixiviation process, as executed by Von Patera, Kiss, Kuestel, and Hofmann, had some serious defects which made it inapplicable to the treatment of certain ores. In the first place it was necessary to subject the ore to a very perfect chloridizing roasting. A high chlorination of the silver cannot always be obtained, especially in case the ore contains calcspar, which is converted by roasting, in part, into caustic lime. The caustic lime not only reduces silver chloride to metallic silver, but also greatly diminishes the solubility of most silver compounds in hyposulphite solutions. In the second place, if the ore contains lead and copper, these metals go, as already pointed out, in part, in solution together with the silver, and are, in the following operation, precipitated with the latter as sulphides. It is well known that such a combination of metals is not desirable for subsequent treatment. No difficulty, however, is experienced if copper only is precipitated with the silver. Finally, we have to consider that although a sodium or calcium hyposulphite solution dissolves—besides silver chloride—silver antimonate and arsenate, and, more or less, metallic or native silver, it does not attack at all either silver sulphide or silver glance, or the group of precious silver minerals known as antimonial and arsenical sulphides, like polybasite, stephanite, ruby silver, and fahl ore. Hence, lixiviation of some classes of raw ores did not succeed where raw amalgamation with chemicals was conducted with profit.

"These defects have been overcome by the Russell process, so named after its inventor, Mr. E. H. Russell.

"Mr. Russell discovered that a solution of a double salt of cuprous hyposulphite and sodium hyposulphite, formed by mixing sodium hyposulphite with copper sulphate, exerts a most energetic dissolving and decomposing action upon metallic silver, silver sulphide, silver minerals belonging to the group of antimonial and arsenical sulphides, and other silver combinations. Hence, if a charge of roasted ore is first lixiviated with ordinary sodium hyposulphite solution to dissolve the silver chloride,

and, subsequently, with a solution containing cuprous hyposulphite—this solvent is called the extra-solution—an additional amount of silver is extracted which would have been lost in the tailings by working according to the old method alone. Or, if the roasted ore contains caustic lime, and is treated with the extra-solution, the deleterious influence of the caustic lime is thereby counteracted. In the same way the extra-solution may be applied to extract silver from raw ores, without previous chloridizing-roasting, or to lixiviate ores after they have been subjected to an oxidizing-roasting.

"Mr. Russell also discovered that lead can be completely separated from a sodium hyposulphite solution, as lead carbonate, by sodium carbonate, without precipitating copper or silver. After decanting the solution from the lead carbonate, silver and copper are obtained from it in the usual way. This method of separating lead prohibits the use of calcium poly-sulphide as a precipitant for the sulphides, because calcium entering the regenerated lixiviation solution would also be precipitated as a carbonate with the lead by sodium carbonate. Hence, sodium sulphide must be employed. A full investigation has demonstrated that this is by no means detrimental. Sodium sulphide and hyposulphite are more advantageously used in the lixiviation process than the corresponding calcium salts.

"Finally, Mr. Russell found that if a hyposulphite solution has a caustic reaction, produced by caustic soda or lime, its solvent power for silver is materially deteriorated. This defect he corrects by neutralizing such a solution with sulphuric acid.

"The Russell process differs from the old or ordinary lixiviation process in the following points:

"1. It requires a less careful chloridizing-roasting, and, on that account, a lower per cent of salt may be used in roasting.

"2. It extracts a higher percentage of silver by means of the extra-solution. This is especially of importance in treating ores raw, and in lixiviating roasted ores containing caustic lime.

"3. It produces sulphides free from lead.

"4. It yields lead in the form of lead carbonate as a valuable by-product.

"5. It overcomes the deleterious effect of a caustic lixiviation solution by neutralizing it with sulphuric acid.

"6. It uses sodium hyposulphite and sulphide exclusively, and not the corresponding calcium salts.

"In comparing the Russell process with amalgamation, the principal items in favor of lixiviation are:

"1. In amalgamation, the coarseness of crushing, without considering the question of roasting, is limited by the capacity of the settler to work off coarse sands without loss of quicksilver. In lixiviation, pulverizing as coarse as possible is desirable. The limit of coarseness depends upon the character of the ore, and, principally, upon the manner in which the silver-bearing minerals are distributed in the gangue.

"2. The original cost of the lixiviation plant is much lower than that of pans and settlers. A further saving is effected by a reduction in size of the engine and boilers.

"3. In amalgamation the pans and settlers consume not less than one and one third horse power per ton of ore. The power for pumping solutions, etc., in the lixiviation process, is merely nominal.

"4. In large mills the quantity of quicksilver in rotation represents a capital of from $30,000 to $40,000, while the stock of chemicals required for lixiviation costs less than one tenth of this amount.

"5. With Russell's improvements, the percentage of silver extracted by lixiviation is in most cases higher than by amalgamation.

"6. Lixiviation by Russell's process requires a less careful chloridizing-roasting, and, in consequence, a lower percentage of salt may be used in roasting.

"7. Ores that can be successfully treated by raw amalgamation give often better results by raw lixiviation with extra-solution.

"8. The value of the lost quicksilver, and cost in wear and tear of the pans and settlers, amounts to more than that of the chemicals consumed in the lixiviation process.

"9. The lixiviation process permits the extraction of copper and lead as valuable by-products.

"10. Amalgamation is invariably injurious to the laborer's health.

"11. In case gold-bearing silver ores have been roasted with salt, lixiviation extracts, in many cases, more gold than amalgamation.

"Almost all silver ores that do not carry a large percentage of lead or copper can be treated by lixiviation with success and economy. I do not mean to create the impression that from ores containing more or less lead and copper a high percentage of the silver cannot be extracted by this process. Such ores, however, will, in most localities, be reduced to better advantage by smelting.

"It is safe to state that all ores fit for amalgamation can also be treated by lixiviation, and that the Russell process may succeed where amalgamation is a failure. The exceptions to this rule will be rare.

"The Russell process is also adapted to the treatment of tailings resulting from ores which have been worked either by the old lixiviation process or by amalgamation. Whether it is most profitable to lixiviate an ore raw, or after chloridizing-roasting, or after oxidizing-roasting, must be determined in each case by actual experiment.

"The operations preceding the lixiviation process, namely: crushing, or crushing and roasting of the ore, are the same as those preceding the well known treatment of amalgamation. In every instance the crushing should be done dry, even in case the ore is lixiviated raw.

"As to crushing machinery, I would always give preference to well constructed rolls, like those furnished by Mr. S. R. Krom, in place of stamps. Pulverizing by rolls produces much less fine dust, and a minimum quantity of the latter facilitates the filtering of the solution through the charge in the lixiviation vats. The size or number of the screen through which the crushed ore should be made to pass, in order to lixiviate with most economical results, can only be determined by a practical test in each individual case, since it depends upon the character of the ore. A No. 8 wire screen may generally be considered as the limit of coarseness. In many cases a No. 20 screen will be used to best advantage, especially if the ore has to be roasted.

"In roasting the ore, those furnaces should be used in which the dust collected in the dust chambers is well chloridized. The Stetefeldt furnace is known to give the most perfect results in that respect. In case the dust remains raw, the proportion of silver extracted is not only diminished for chemical reasons, but the mechanical difficulties in lixiviating such fine material are also increased in proportion to the imperfection of its roasting.

"The lixiviation plant proper, used in the Russell process, does not differ materially from that employed in ordinary lixiviation. Many improvements, however, have been introduced. These are, principally, the construction of large lixiviation vats of sixteen feet diameter and six to seven feet depth; the introduction of the Korting ejector for facilitating the filtering of the solutions; the filter press for collecting the sulphides.

"The solutions are manipulated as in ordinary lixiviation, with this difference, that the extra-solution is frequently circulated; that is, withdrawn by a Korting ejector from below the filter of a lixiviation vat and returned on top of the charge.

"It is beyond the scope of this article to describe how the application of the solutions varies in the treatment of different ores.

"Roasted ores may be divided into two classes—'acid' and 'alkaline' ores. The former give a wash-water with acid reaction, while the wash-water of the latter is alkaline, caused by the presence of caustic lime.

"It is with the alkaline ores that the Russell process has achieved its greatest success, compared with ordinary lixiviation. As a prominent example, I note the results at the Yedras Mill, Sinaloa, Mexico. The ore is crushed by stamps through a No. 20 wire screen, and roasted with 7 per cent salt in reverberatory furnaces.

STATISTICS OF ORDINARY LIXIVIATION.

From June 1, 1887, to February 1, 1888.

Number of tons treated	5,785
Value per ton in silver, ounces	60.67
Per cent of silver extracted in assay office with ordinary solution	72.09
Per cent of silver extracted in the mill	67.12
Total time of lixiviation, hours	92
Chemicals consumed per ton of ore:	
Caustic lime, pounds	9.07
Sulphur pounds	4.07
Cost per ton, Mexican coin	$0 66

STATISTICS OF THE RUSSELL PROCESS.

From November 1, 1887, to February 1, 1888.

Number of tons treated	1,772
Value per ton in silver, ounces	55.03
Per cent of silver extracted with ordinary solution in assay office	69.94
Per cent of silver extracted with extra solution in assay office	83.62
Per cent extracted by the Russell process in the mill	82.44
Total time of lixiviation, hours	76
Chemicals consumed per ton of ore:	
Sodium hyposulphite, pounds	1.4
Copper sulphate, pounds	9.6
Caustic soda, pounds	5.5
Sulphur, pounds	3.6
Cost per ton, Mexican coin	$2 78

"It will be seen that ordinary solution extracts in the assay office are 4.97 per cent more silver than in the mill, and that the mill results are 15.32 per cent in favor of the Russell process. The gain in extraction on ore assaying sixty ounces silver per ton would be nine and nineteen one hundredths ounces, or $11 17 Mexican coin, less increased expense of chemicals, $2 12, leaving a net profit of $9 05 Mexican coin.

"Most remarkable are the results of an experimental run recently made at the Ontario Mill, Park City, Utah. The ore was crushed in a battery of twenty stamps through a No. 10 wire screen, at the rate of ninety-eight tons per twenty-four hours. This quantity was roasted without difficulty in one Stetefeldt furnace, and the extraction of the silver by the Russell process was 94 per cent. Under such circumstances the total expense of treatment by lixiviation would be only about one half of what it now costs to amalgamate.

"Those who wish to obtain full information about the Russell process, and lixiviation generally, will find it in C. A. Stetefeldt's treatise, 'The Lixiviation of Silver Ores with Hyposulphite Solutions,' with special reference to the Russell process."

NOTES ON THE HYDROMETALLURGY OF GOLD.

By C. H. Aaron, Assistant in the Field.

In the years 1878 to 1881, I had the costly privilege of discovering and announcing a heavy loss of gold by volatilization during the roasting of auriferous pyrites under certain conditions. The account of my experience may be found in my handbook of "Leaching Gold and Silver Ores." Whether I was the first to publish the fact or not, it is certain that my statement was doubted, and even ridiculed by several prominent metallurgists. To-day every operator, in California at least, is on his guard against this danger. Other investigators have followed from time to time, and have confirmed my results, or have claimed the discovery *de novo*. The latest and most complete examination of the subject is that of Professor Christy, of the California University, whose paper* is published in "Engineering and Mining Journal" of September 8, 1888. The loss in my case was due to the addition of about 2 per cent of salt to the raw charge, on account of silver contained in the ore; and when this was discovered, the method adopted, which was successful in preventing any appreciable loss of gold, was to complete the dead roasting (as to iron), then cool the charge somewhat, add the salt, mix it with the ore as quickly as possible, and *immediately* withdraw the charge from the furnace, allowing it to remain in the hot pile for some hours before being spread to cool. It was found, however, that in this way the extraction of the silver was not so satisfactory as before; this was remedied without detriment to the gold, by the addition of two or three pounds of finely ground salt per ton to the raw charge, the remainder being added at the finishing, as said. I now regret that I did not ascertain the percentage of the silver, which was soluble before the last addition of salt, which may have been superfluous.

In the muffle experiments of Professor Christy, it is shown that more gold was lost when the salt was added after an oxidizing roasting than when it was mixed with the raw ore, and the Professor has taken some pains to account for the apparent discrepancy between his results and mine by the aid of some interesting facts which he has discovered in regard to the recovery of volatilized gold. In fact, however, the discrepancy vanishes when it is considered, which the Professor seems to have unaccountably overlooked, that in his experiments the roasting was continued after the addition of salt, while in my practice it was not. My method is now in general use throughout California where the Plattner process is practiced, and I have been amused by the manner in which the very men, or some of them, who made disastrous failures in working the Murchie sulphurets before I got them and came very near to doing the same, now talk as though they had always known all about it and had never worked in any other way.

Mr. Stansfield, of Nevada City, tells me that there is some loss of gold in roasting without salt, which bears out my often expressed views as to the error of roasting the assays when the actual gold content of the ore is

*"The Losses in Roasting Gold Ores and the Volatility of Gold," by Samuel B. Christy, Professor of Mining and Metallurgy, University of California, Berkeley, Cal.

required. He states that in one instance the loss amounted to 25 per cent of the value, but did not know, or did not say, whether or not the ore contained tellurium or selenium. Professor Christy also found a loss in some of his muffle roasts without salt, but ascribed it to the effect of chlorine pervading the air of the laboratory. This matter must be looked into.

The Professor has proved that gold is volatile, in the presence of chlorine, at all temperatures from that of boiling water to a white heat, and that the amount of the loss depends upon time, heat, surface exposure, and quantity of chlorine, as might have been expected. He also finds that gold thus volatilized, at least at the temperature of roasting, cannot be recovered by simple condensation of the fumes; it is necessary to employ some agent which can decompose the volatile gold chloride. It appears that sulphur dioxide in the presence of water does this, just as it decomposes the ordinary gold trichloride dissolved in water, precipitating the gold in the metallic state. In a long furnace, with several hearths, the salt is added on the finishing hearth; at the same time the ore on the next hearth is burning and giving off fumes of sulphur dioxide; hence it is only necessary to draw the smoke from the furnace through a sufficiently high coke tower, the coke being constantly wet by a small stream of water, when the gold fume is decomposed, and the metal is precipitated on and among the coke, or remains in part suspended in the water, which must, therefore, be filtered before running to waste. The same water may be elevated and repassed until it becomes too acid. Charcoal may be used instead of coke, and I suggest that probably quartz would also answer. The coke or charcoal has to be burned in order to recover the gold, but quartz would only require washing. It would be necessary to force the draught by suction, and the Professor suggests a Guibal fan or a Root blower, made of wood, and painted with asphaltum and coal tar for this purpose, a small Pelton wheel being used to operate it where water power is cheap. I have no doubt a steam jet, properly applied, would answer, and the steam, condensing partly in the tower, would do no harm at least. However, it is doubtful if such an arrangement would be profitable, so long as the roasting is properly conducted.

I believe the use of salt in the roasting is now almost universal in California, since Deetken introduced it in 1866, on account of magnesian matter in the Eureka sulphurets, which for a time baffled the local operators, but in the absence of silver, magnesia, and lime it does not seem to be necessary.

A loss of gold may occur through too rapid roasting, the heat being too high, and the fine particles of metal being carried away by the violent evolution of the gases of combustion; in fact, prior to 1880, gold was not supposed to be lost in any other way during the roasting. The effort to roast fast in charge furnaces has been a prolific source of failures in both gold and silver works. The Professor says his attention was first called to the subject of the loss of gold by Mr. C. H. Crosby, in 1880, who informed him that, in roasting Murchie sulphurets with 3 per cent of salt, he lost 30 per cent of the gold and 50 per cent of the silver. It was the failure of Mr. Crosby and other local operators to treat these sulphurets that caused them to be sent to Melrose, where Mr. Wm. Irelan, Jr., and myself, in partnership, undertook to work them, and nearly came to grief as others had done, from which, however, we were saved by my opportune discovery. But our loss of gold was only 15 per cent, and that of silver did not approach 50 per cent, since we always extracted far more than half, although, if I remember rightly, we fell a little short of our guarantee of 80 per cent all the time, which was compensated by our extracting over 90 per cent of the gold, after my discovery. The difference between our losses and those of

Mr. Crosby was probably caused by the circumstance that we used a three-hearth furnace, while his furnace had but one hearth and an oxydizing cylinder which discharged into a chamber at the end of the reverberatory hearth, and the fumes from the latter did not pass through the cylinder, so that Mr. Crosby lost the advantage which might have been derived from a fact which Professor Christy has shown, which is, that iron pyrites can decompose the volatile gold chloride, thereby becoming enriched. In our furnace, the fumes from the first two hearths had to pass over the charge on the third hearth, and it was scarcely possible to crowd the work very much, although, even with us, too much of that was attempted at first by having more men at work than could do any good, and by urging the fires, etc.

I do not approve of a storied furnace, one hearth above another, for this work. Three hearths on this plan would be very inconvenient, and when there are but two, the upper one, on which the new ore is laid, is liable to be heated too much from below, where the heat can do little good for want of air to enable the sulphur to burn. What the ore needs, at first, is just enough heat to cause the sulphur to burn, and a plenty of air; then stirring only when the surface glow begins to fail, the heat being gradually increased as requisite to continue the combustion, until, on the finishing hearth, it is raised to that necessary for the complete decomposition of all iron sulphate formed previously and not yet decomposed.

It does not appear that any important advance has been made in the means of roasting the auriferous pyrites in California. The reverberatory furnace with three or four hearths still holds its ground, though rotating cylinders of the Brückner type have been successfully applied, and I entertain no doubt that inclined cylinders of the White type may be equally so, if intelligently used, and with suitable modifications to meet the requirements of this kind of work. Nor are we called upon to consider anything essentially new and important in the chemistry of the only process which is or has been in extensive use for the extraction of gold by leaching, namely, that invented by the illustrious Plattner.

What we have to consider in this connection, is a radical change in the manipulation of the roasted material, as now practiced in several large establishments east of the Rocky Mountains, where many thousand tons of auriferous pyrites have been treated within the last few years. This change consists mainly in the following points:

Instead of applying the chlorine gas, generated in a special apparatus, to the slightly moistened ore in a stationary filter vat, which requires from twenty to forty hours for the conversion of the gold to a soluble chloride, the chlorine is generated within the vessel containing the ore and a sufficient quantity of water to form a mobile pulp. The vessel employed is a rotating barrel, similar in form and manner of use to the amalgamating barrel for silver ore. The chlorine is usually developed from the so called chloride of lime, or bleaching powder, and sulphuric acid. In this way it is possible to obtain a high degree of pressure, and it was at first supposed that such pressure constituted an important feature, and at the same time a serious difficulty of the process. But we are now assured, on excellent authority,* that any considerable pressure is of no utility; in fact, it is only necessary that the pulp be saturated with the gas.

By the above outlined method, the chlorination of a charge requires, usually, only a couple of hours, and the cost of a plant for the treatment of large quantities of material is said to be less than by the old method

*That of R. P. Rothwell, C.E., M.E.

which, in order to work on a similar scale, would require a large area of vats, and buildings to correspond. When the chlorination is finished, the pulp is transferred to filter vats, and the gold is extracted by leaching as usual, or, if necessary, aided by suction.

This is the "Mears" process. When it was first introduced, attempts were made to work by generating chlorine in the usual way and forcing it into the lead-lined iron barrel by means of a pump; and, as a pressure of about forty pounds to the square inch was used, great difficulties were experienced, as will be readily believed by those who are acquainted with the properties of chlorine.

As to the advantages of the process, as now worked, while I hope before closing this article to receive a full account from the East, my present opinion is that, unless in cases where it yields a notably higher percentage of the gold than by the old method, the game is not worth the candle. The great advantage of the old method is that it requires no moving machinery; there is nothing to break down, and but little to wear out. A set of vats once installed will last a long time if properly cared for, and will consume nothing more than a little coal tar and asphaltum, or paraffine, from time to time. Mere rapidity in working is of secondary importance; the works of suitable capacity once started with a constant supply of material to treat, the same daily output is obtained if each charge takes three days as if it took only three hours to work. And I see no reason why vats of fifty tons capacity should not be used in gold leaching as they now are in silver leaching; also they might be arranged to be discharged by sluicing out the tailings, instead of shoveling, as is also done in silver leaching. Working twenty or more tons of material per day, with fifty-ton vats, I doubt if the Mears process can offer any advantage unless it be in an increase of the percentage extracted, as in case of rather coarse gold, or that which contains a considerable proportion of alloyed silver; in the latter case the movement and friction in the barrel would do good by removing the film of silver chloride which would otherwise obstruct the action of the chlorine on the golden particles; or, in case of material rich in silver, or lead, or both, like that which O. Hofmann found it necessary to treat by leaching with hypo before chlorinating the gold. In the matter of precipitants for the gold, there is nothing really new to note; ferrous sulphate generally answers very well, and where, as in one case in my experience, it does not, hydrogen sulphide supplies its place satisfactorily. The use of animal charcoal for this purpose, though very effective, and involving no trouble in the matter of settling, has not found favor; there seems to be a difficulty in the separation of the gold from the carbon, the only feasible way being to redissolve the metal by means of aqua regia, and again precipitate it by some one of the known reagents for that purpose. The same applies in a less degree to the use of wood charcoal, though that is more easily disposed of by burning, the gold being recovered from the ashes by melting them with borax, etc.

Sulphur dioxide (sulphurous acid) is an excellent precipitant for the gold, which it throws down in the metallic state in the form of a dark powder; it is easily produced by heating strong sulphuric acid and either charcoal or sulphur, in an iron retort, the resulting gas being passed into the solution of gold. There are many other substances which throw the gold down in the metallic state, and among them is one which I am inclined to think may be the best of all precipitants for practical use—that is precipitated copper sulphide. The copper sulphide is converted into sulphate, which dissolves, while the gold is deposited in the metallic state, in a good form for collection. The copper sulphide may be recovered from the

liquid by precipitation by means of either hydrogen sulphide or an alkali sulphide, though in the latter case it would be mixed with some free sulphur, which would then become mingled with the gold, but could be easily burned off. The copper sulphide may be applied by stirring it into the gold solution until a test shows that no gold remains dissolved, but a better way would be to let the gold solution flow slowly through a series of small filters containing the sulphide. When the copper sulphide in the first filter is almost entirely replaced by gold, that filter must be emptied, refilled with copper sulphide, and replaced as the last of the series, the former second becoming the first, and so on. The precipitated gold may be freed from remaining copper sulphide by digestion with some warm, strong gold solution. This method offers advantages in the collection of the gold, which is thrown down in a granular condition, and, when washed and heated, assumes the golden color. Any remaining traces of copper sulphide become oxidized in the heating, and may be removed by a little nitric acid, leaving pure gold for melting. I think enough gold is lost, in most works, by imperfect settling, to pay the cost of this method of precipitating.

In using iron sulphate for the precipitation, I found that after forty-eight hours' settling there remained gold in suspension to the amount of half a dollar for each ton of ore treated. The settling is promoted by the addition of some sulphuric acid to the liquid; also by repetition of the stirring about two hours after precipitation. When the ore contains copper, the liquid from the precipitation vats is conducted to other vats containing scrap iron which precipitates the copper. The cement copper thus obtained always contains gold, and this appears to have produced an impression that iron sulphate does not precipitate all the gold from solution. My experiments have shown that when a sufficient quantity of iron sulphate is added no gold remains dissolved; the gold found in the cement copper must, therefore, be that which had remained in suspense, and it indicates that, in case there is no copper to precipitate, the loss from this cause may be considerable. In this connection I will mention for the benefit of those who may choose to try it, that John Tunbridge & Son, of Newark, New Jersey, have a peculiar filter which seems well adapted to the collection of suspended gold.

In the "Engineering and Mining Journal," of November 28, 1885, is an article by Nelson A. Ferry, E.M., who recommends the addition of molasses to the leach when lime is present. Mr. Ferry says: "Dissolve one gallon of molasses in thirty or forty gallons of water, and keep for use. The quantity to be used must be determined in each case by a laboratory test; if calcium sulphate comes down, either the molasses is in insufficient quantity, or it has not been thoroughly mixed. Examine by transmitted light. Avoid large excess of ferrous sulphate." If the gold comes down at first in a flocculent form it is no matter; it soon assumes the usual form. The best results are got when the liquid is made slightly acid.

The usual practice in such a case is to add sulphuric acid to the leach, and let it stand for a number of hours, then transfer the liquid to another vat, and precipitate the gold with iron sulphate; the gypsum crystallizes on the side of the first vat. This method requires a double set of precipitating vats.

The following description of the Newberry Vautin process was kindly furnished me by Walter McDermott, M.E., of New York, who received it from an English source. The process has been used successfully in Australia, and is essentially the same as the Mears process.

"In the Newberry Vautin process the manner of dealing with a material containing gold is simple. The principal parts of the machine are few: a

hopper, chlorinating barrel, reservoir for the liquid from the filter, and the charcoal collector. The hopper is fixed above the chlorination barrel, into this the crushed and roasted ore or tailings are poured. The barrel is made of iron, lined with lead, this again with prepared wood; it is sufficiently strong to bear a pressure of one hundred pounds to the square inch. In form it is cylindrical, and in the center are two valves directly opposite to each other. One valve is sufficiently large to allow the pouring in of a stream of sand; the other is smaller and is for the introduction of compressed air.

"The charge falls from the hopper through the larger valve; when the required amount is poured in chlorine-producing chemicals are added, commonly chloride of lime and sulphuric acid; sufficient water is introduced so that the mass may assume a semi-liquid state. The valve cover is then screwed down, and the barrel turned half round so that the small valve is uppermost. To this is attached an india rubber pipe, leading from an air pump, and compressed air is forced in until a pressure of about sixty pounds to the square inch is reached, when the valve is screwed down and the hose disconnected. By means of a friction wheel, the barrel is set revolving at a speed of about ten revolutions to the minute; this brings the chloride of lime and sulphuric acid into combination, and produces the gas, which, under the pressure now in the barrel, becomes liquid and mixes with the water, so that a strong solution of chlorine is in a continual state of agitation through the ore. The gold contained in the ore, from its contact with the chlorine solution, forms into a chloride of gold, and, being soluble in water, it becomes absorbed by the liquid in the barrel.

"The time occupied in reducing the gold to this state varies according to the size of the gold grains and the nature of the ore; with very fine gold one hour should be sufficient, but in particular cases four hours may be necessary. The chlorinator being stopped, the hose is again attached, and the compressed air mixed with gas allowed to escape into lime water to prevent the inhalation of any disagreeable fumes. The large valve is then removed, and the barrel set revolving as before; at every downward turn it discharges a portion of its contents into a chute leading to the leaching vat below. When almost all its contents are discharged a few buckets of water are thrown in, which, by the revolution of the barrel, are swirled around, thus completely washing into the filter all remaining solution. The filter is an iron vessel lined with lead, with a double bottom; to the lower part of this a pipe is connected leading to a vacuum pump.

"When the ore from the chlorinator has filled the filter, the air is drawn from between the double bottoms of the latter, which causes very rapid filtration. The filtered liquid is drawn off through a pipe into a vat. A continuous stream of water is kept playing upon the tailings in the filter, which by the suction is drawn through them, so that all the chlorides are washed out. To prevent any clogging of the material, the action of the exhaust pump is made intermittent. The solution, as it runs into the vat, being continually tested, it is easy to know when the work is completed; then the water is cut off and the pump stopped. The filtration generally occupies about one hour. The stuff in the filter is tipped into a truck running on a line of rails below, by which means it is run to the tailings heap.

"The liquor drawn from the filter contains gold in solution, lime, magnesia, copper, zinc, etc., according to the nature of the ore; also in all instances it retains a greater or less proportion of free chlorine. This being a deterrent to the decomposition of gold chlorides, it becomes necessary to dispel it, which is done by blowing air or steam through the liquid.

If the water is entirely free from chlorine gas, decomposition of the gold chlorides occurs very rapidly when passed through charcoal. At the bottom of the vat a tap is fixed, to run the liquid slowly through a filter of charcoal. Contact with this material returns the gold chlorides to metal, and they are deposited amongst its pores and fibers and on its surface. Copper, lime, magnesia, and zinc are not touched by this reagent, so they pass through in a soluble state. The charcoal may be then burned, the ashes melted in a crucible with borax, and the ingot of metal obtained."

The foregoing description, though rather crude in some points, gives a good general idea of the process. The writer seems, from parts of his paper not here quoted, to contemplate treating unconcentrated ores, as well as concentrates. This is not often, if ever, done here, though I am aware of an instance in the republic of Salvador, in Central America.

For the subjoined description of the Mears process as conducted in Canada, I am indebted to the courtesy of John E. Rothwell, M.E., who is now filling, with credit to himself, the important and responsible position of Superintendent of the extensive works at Deloro. It will be observed that this description, unlike that of the Newberry Vautin process, is written by one who is thoroughly and practically acquainted with his subject, and from actual experience. It will also be noted that the view I have expressed in another part of this article, as to the feasibility of using a properly modified form of the White furnace for this class of work, is fully sustained by facts, the results being all that could be asked for, and reflecting the highest credit on the management of the works.

I have endeavored, without avail, to obtain a description of a new style of furnace, which is in use at the Treadwell Mill, on Douglass Island, Alaska. From what I can learn, this furnace is a modification of the Spencer furnace, an automatically working shelf stack, in which the ore is pushed from shelf to shelf by machinery. There is no doubt that the old fashioned reverberatory has seen its best days in this branch of metallurgy, and will in future be used only in works of small capacity.

METHOD OF WORKING AN ARSENICAL SULPHURET OF IRON ORE, FOR GOLD, AS PRACTICED AT DELORO, CANADA, BY JOHN E. ROTHWELL, M.E.

"The ore, after mining and hoisting, is hand sorted, then sent to the mill, where it is crushed in rock breakers and Cornish rolls to pass through a No. 16 mesh; it is then sized and run on the jigs for concentration. The concentrates are roasted in two large Howell-White revolving cylinders.

"The roasting furnaces are arranged so that a preliminary roasting is carried on in the one, in which the arsenic and sulphur is nearly entirely driven off, then the ore runs by gravity into the second cylinder, and is there roasted dead or sweet; it falls from the lower end of the second cylinder to the cooling floor, and is there spread out to cool. When cool it is loaded into iron hopper cars and sent to the chlorinators.

"These furnaces have a number of important improvements from the original furnaces, by which they are able to treat a very large amount of ore, and also without the usual heavy loss and trouble with dust, which is always one of the chief objections to their use.

"The chlorinators are cylinders of one fourth-inch boiler iron, with cast-iron heads riveted or bolted on each end; each head has a long trunnion that is turned true, and acts as the journal bearing and driving shaft.

"The trunnions are cored out, and have a shafting box and gland fitted to the end.

"The cylinders are lined with twenty-pound sheet lead, the joints all being burned together.

"The chlorinator, to hold a charge of one ton, is forty inches in diameter by forty-four inches long, inside measurement. One to hold three tons is sixty inches diameter by seventy-two inches long. A manhole is provided in the center of the shell, to be able to get inside of the cylinder for repairs. In the manhole cover is the opening for charging and discharging the pulp. This opening is fitted with a light and strong lead-covered cover, arranged to be easily and quickly removed. On the inside of the cylinder, and on that side from the charging hole, in the direction in which the cylinder revolves, is a lead-covered pocket, the lead of which is burned to the lining of the cylinder. The capacity of the pocket of a one-ton chlorinator is about one hundred pounds, and a three-ton, three hundred pounds of sulphuric acid. Several lead-covered shelves are bolted to the inside of the cylinder for the purpose of stirring the pulp thoroughly.

"Through the trunnion is passed the goose-neck, which is an iron pipe covered and lined with lead, and turned smooth and true where it passes the stuffing box and gland. Inside the cylinder it is bent up, and the top end, which just clears the shelves, is turned in the direction in which the cylinder revolves. The goose-neck is held stationary in the upright position by clamps.

"The object of the goose-neck is to be able to draw off or pump the gas into the cylinder while it is in motion, and when a pressure gauge is attached the variation of pressure can be noted. The charging is done in the following manner: The car from the cooling floor is hoisted to a platform over the chlorinators; the charge of chloride of lime placed on the top of the ore. The water, about one hundred and twenty gallons to the ton of ore, is measured into the cylinder first; then the ore from the car is let in, and after examining the acid pocket to see that no ore or lime has got into it, the sulphuric acid is poured in through a funnel; the cover is put on and fastened tight, and the cylinder started.

"The proportions of bleach to acid used at Deloro were: Chloride of lime, 6; acid, 7. The quantity of each varies with the quality and roast of the ore.

"At the end of the time allowed for the cylinder to revolve—usually from one and a half to three hours—the excess of gas is drawn off through the goose-neck, and an exhaust pump or ejector attached to produce a partial vacuum, the cylinder revolving all the time. In this way the most of the free gas is got rid of. Then the cover of the discharge hole is quickly removed and the charge dumped on a sand filter in a tank with a tight-fitting cover and exhaust pipe.

"The other method used, which is much simpler and quicker, is washing the charge in the chlorinator. After the gas has been exhausted the cylinder is filled with water and allowed to revolve a few times; the liquor allowed to settle a short time and then the supernatant liquor decanted into a series of settling tanks; this is repeated until the liquor shows no gold on testing.

"In this way a charge of three tons can be thoroughly washed in from two to three hours, while a one-ton charge on a sand filter requires from six to eight hours.

"The clear solution from the settling tanks and filters is run into the precipitating tanks ready for the precipitant.

"The precipitant used is hydrogen sulphide gas, made from paraffine and sulphur in the following way:

"The generator is a small cylinder of heavy boiler iron, with cast-iron heads riveted in, and all the seams well caulked.

"In one of the cast-iron heads is a hand hole, used to clean out the residues from the charge, and in the shell of the cylinder is the charging hole and a piece of two-inch gaspipe, the outlet of the gas.

"The charging hole is fitted with a tight cover, easily removed.

"The generator is built in a small brick fireplace, leaving the charging hole and gas outlet on top free, and the discharging hole accessible from the outside.

"After charging with the proper proportions of paraffine and sulphur, a light fire is all that is necessary to generate gas.

"The best proportions, using single-pressed paraffine and common brimstone, are one to two.

"The precipitating tanks are fitted with a tight cover, with an exhaust pipe leading out of the building for the escape of gas during precipitation, and a manhole with a tight cover. Near the bottom of the tank is a perforated lead pipe, one end coming up through the cover and fitted with a hose connection.

"In front of the precipitating tanks is a line of steam and gas pipes, fitted with T's, valves, and hose connections for each tank.

"The gas from the generator passes into a receiving tank, where the volatile oils, etc., that will condense, will collect. From the receiving tank the gas is drawn by a small air pump and forced through the line pipes to the tanks and through the solution to be precipitated.

"To avoid creating a vacuum in the generator and gas receiver, a small air hole is left in the receiver. In this way the pump is able to work much faster, and by driving air through the solution materially aids the precipitation and reduces the amount of precipitant used.

"The tank, after the precipitation is complete, is allowed to stand for a short time and then several of the small pressure-filters, described in the "Engineering and Mining Journal," March 25, 1885, are attached, and the solution allowed to flow through them. Three of these filters will empty a one thousand five hundred-gallon tank in from three to four hours and leave it ready for another precipitation, or the precipitate can be collected in another filter press, pressed into cakes, dried, roasted, and melted with borax.

"The ore treated is an arsenical sulphuret of iron, in a gangue of quartz and calc spar, an analysis of which gives—

Arsenic	About 42 per cent.
Sulphur	About 20 per cent.
Iron	About 38 per cent.

"An average assay value of a number of tons of the roasted concentrates treated in the chlorinators gave $78 67, and the tailings assayed $3 per ton, or 96.16 per cent of the gold in the ore was extracted."

Just in time I have received the following valuable letter from Concord, North Carolina:

PHŒNIX MINES, October 15, 1888.

C. H. AARON, *Esq., San Francisco, Cal.:*

DEAR SIR: In my former letter to you I promised to write an article on the "Hydrometallurgy of Gold," but seeing through pressure of business that it will be impossible for me to do justice to the subject, to get it ready for print by the first of November, I will here give you a brief description of the barrel chlorination, as in practice at the Phœnix Mines, North Carolina, and the Haile Gold Mine, South Carolina.

The success of the barrel chlorination I attribute to the generation of chlorine in the ore pulp, to attrition, and to quick filtering.

The original Mears process was based upon pressure of chlorine, either generated outside and forced by a pump into a lead-lined cylinder through a hollow trunnion, or gener-

ated by the use of chloride of lime and sulphuric acid in such quantities as would create a pressure of from thirty to forty pounds per inch. To ascertain the pressure a lead-lined gaspipe in the form of a goose-neck, and called so, passed through the hollow trunnion, was securely fastened, provided with a stuffing box, and connected with a pressure gauge. In using chloride of lime the inner lead lining of the cylinder was provided with a sulphuric acid chamber capable of holding one hundred pounds of acid. While, indeed, the result in working well roasted ores was satisfactory, the annoyance through leakage, the continued wearing out of goose-necks, the collapsing of the inner lead lining by a too strong exhausting of the gas, by being too often deceived as to the pressure of chlorine, when pressure, but no chlorine, was present, causing rehandling of the ore, made the process an expensive and unsatisfactory one.

In this annoying way I worked for nearly two years, testing, meanwhile, the effect of a highly saturated chlorine water under attrition without pressure, and when, after repeated tests, I found my results equally as good without pressure as with the highest pressure, and better when I divided the requisite amount of chloride of lime and sulphuric acid, so as to have nascent gas during the time of working, I remodeled the chlorinator by closing up the hollow trunnion, removing the goose-neck and acid chamber, and substituted a lead valve connected with the inner lead lining in such a way that the pressure of free chlorine can be ascertained at any moment, and no charge subjected to chlorination need be thrown on the filter without full knowledge of the work being complete. The cast or sheet-iron cylinder (chlorinator) is forty-two inches diameter by sixty inches long.

The heads are cast and securely bolted to end flanges, and provided with tight and loose pulleys. The bung for the introduction of the roasted ore and chemicals, six inches diameter, is provided with a lead lined cover, which, before rotation, must be closed hermetically.

The interior of the cylinder is lined with sheet lead of ten to twelve pounds per square foot. The capacity of chlorinator is from one to one and one fourth tons of roasted ore. Before introducing the ore, the chlorinator is charged with from one hundred to one hundred and twenty-five gallons of water, or I might say enough water to make an easy flowing pulp. This done, the roasted ore is introduced; half the requisite quantity of sulphuric acid is then poured in, and lastly half the required chloride of lime, when the bunghole is closed, and the chlorinator set in motion at the rate of about fifteen revolutions per minute.

For Phœnix ores I use forty pounds chloride of lime and fifty pounds commercial sulphuric acid per ton of roasted ore, but I charge twenty pounds of chloride of lime and twenty-five pounds of acid first, rotate for three or four hours, open the bung, and charge the other half, having found better results by dividing the chemicals. Rotate for two or three hours longer, and if, by the aid of the lead valve, free chlorine is found present, the cover is removed from the bunghole and the chlorinated ton of ore thrown on a shallow filter six by eight feet, provided with a five-inch filter-bed over which the pulp spreads to a thickness of about four inches. The filter, before the ore pulp is thrown on it, is first flooded with clear water from below, and when the water stands over the filter the discharge hole is corked, so that the water acts as a cushion against the ore pulp, prevents the packing of the filter-bed, and admits of a free filtering.

When the chlorinator has been emptied on the filter, the cork is removed and the solution allowed to pass into a stock tank below. As soon as the first solution has passed through so that the ore surface is exposed, from three to four inches of water are added over the whole surface, and when this is filtered through and the ore surface exposed again, the whole space above the ore, about eleven inches in depth, is filled, which, by practice on Phœnix ore, has proved sufficient to remove all the chloride of gold; but should there be still a reaction with ferrous sulphate, more water must be added. The filters are lead lined, eighteen inches deep, and have fall of one inch towards the outflow. The bottom is first covered with perforated glazed tiles of clay or of mineraline, which is impervious to the action of acids and chlorine. On this rests the gravel filter-bed, which is topped off with ordinary clean river sand. To prevent the filter from getting an uneven surface, longitudinal one and one quarter-inch wooden slats eight or ten inches apart keep it in place.

The filtering should be accomplished as quickly as possible, but as this depends generally on the fineness of the ore treated no rule can be established. As long as the solutions show the presence of chlorine when the last wash water has passed through the filter, there is no danger of not having clean tailings.

The solutions accumulating in stock-tank are let off into smaller tanks for precipitation with ferrous sulphate, which should always be regenerated if not active, so as to destroy any ferric sulphate which will dissolve precipitated gold.* Care should be taken by examining after twenty-four hours to ascertain if all the gold has been precipitated, as losses have occurred by a partial precipitation.

The tanks for precipitation should not be too deep; a convenient size is six to eight feet in diameter and three feet high, holding the solution from about three tons of roasted ore. A sufficient number should be on hand to allow the precipitate at least three days to settle. After three days settling in shallow vats the supernatant liquor can be drawn off, and fresh solutions added for precipitation. At the Phœnix, the liquor is passed over metallic iron, and the copper recovered as cement.

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* Ferric sulphate will not dissolve gold in presence of ferrous salts.—C. H. A.

From the precipitating tanks the precipitate is finally collected, washed as clean as possible to remove the iron salts, dried, and melted. The amount of chloride of lime and acid used at the Phœnix I have stated as forty and fifty pounds respectively, which is due to the presence of quite an appreciable amount of chalcopyrite. An excess of acid should always be used so as to convert all the lime into a sulphate to remain in the filter. The solution should react slightly acid; if neutral, soluble chloride of lime will cause a bulky precipitate with ferrous sulphate.

At the Haile Mine, where I have to deal with a pure iron sulphuret, I use at present but ten pounds of chloride of lime to fifteen pounds of acid, and treat four tons of roasted ore in two chlorinators during ten hours, and I have not failed to extract 94 per cent of the assay value.

The Haile Mine ores, which have been so long the bugbear for economic treatment, and on which so many experiments have failed, are offering no obstacle to the barrel chlorination, and are cheaper and easier to chlorinate than the Phœnix ores.

As the success of chlorination, by whatever process, depends on a thorough roast, assuming that we have clean concentrates, it is of the utmost importance that the roaster should have some guide to go by, and to this end I let him test every charge before drawing, by a bright filed iron rod. A small portion of the roasted ore is boiled in water and stirred with the bright iron; the least trace of sulphates will stain the iron—a sign for the workman that the roasting is not completed. At the Phœnix I use a revolving pan furnace of twelve feet diameter, with a short reverberatory attached. From two working doors the roaster can rabble the ore. When a charge is finished the ore is discharged, through the hollow axis on which the pan revolves, into an outer circle below, and then removed, by scrapers attached to the bottom of the pan, into a car and delivered to the cooling floor from where it is elevated into the chlorination house. Such a pan furnace roasts one ton of raw ore in twelve hours with a consumption of three eighths of a cord of wood and 90 cents for labor. The power necessary to drive the pan is a small item, and will not exceed 25 cents per ton of raw ore.

At the Haile Mine a double reverberatory furnace furnishes two tons of roasted ore every twenty-four hours, with an average consumption of one cord of wood at $1 25 per cord, and four laborers. The cost per ton of roasted ore amounts to $2 62½.

The cost of chlorination by the barrel process depends chiefly on the number of tons chlorinated per day. Two men can easily chlorinate four tons in ten hours, elevate the ore, and clean out the filters, of which I have four to each chlorinator, and having arranged on this basis the work at the Haile Mine, the cost for chlorinating four tons daily is as follows:

Forty pounds chloride of lime, at 3 cents	$1 20
Sixty pounds sulphuric acid, at 2 cents	1 20
Two laborers, at 90 cents	1 80
One chlorinator	2 00
Motive power	50
Total	$6 70
Or $1 67½ per ton.	

Add to this 12½ cents for sulphuric acid for making sulphate of iron, and 20 cents for repairs and wear, which is more than liberal, and we have the sum of $2 per ton for chlorination, or $4 62½ for roasting and chlorinating one ton of roasted ore, representing one and one third tons of raw iron pyrite. Inside of seven hours from the time the ore is in the chlorinator the solutions are ready for precipitation and the tailings clean. The wear on the inner lead lining of the chlorinators is imperceptible—a chlorinator in use at the Phœnix for over five years does not show any wear on the lead. That the barrel chlorination has advantages over the Plattner process cannot be gainsaid, and its successful working here and at the Bunker Hill, Amador County, where it surpassed the Plattner in results, will undoubtedly lead to its adoption in such regions where the auriferous sulphurets are an important factor in the production of gold.

Hoping that these notes will aid you in your work, and ready to give any desired information, I remain,

Very truly yours,

A. THIES.

NOTES ON THE HYDROMETALLURGY OF SILVER.

By C. H. Aaron, Assistant in the Field.

In regard to the means or manner of roasting silver ores for leaching, it does not appear that any new invention or discovery of importance has been made in the last few years. The furnaces in use are the Stetefeldt, the revolving cylinders of both the White and the Brückner type, and the old reverberatory oven. There is an instance, at the Yedras Mine in Mexico, of reversion from the Brückner cylinder to the reverberatory, with the advantage, as stated by G. J. Rockwell in a series of articles on "Chloridizing Roasting and Lixiviation at Yedras Mine," in the "Engineering and Mining Journal," of February 4, *et seq.*, 1888, that ore which balled insufferably in the cylinder was roasted in the reverberatory with little or no inconvenience.

I have met with a bad case of balling in a cylinder furnace in my own experience, and though the cause and character of the balls seem to have been different in my case, yet I believe the ore might have been roasted successfully in a reverberatory furnace, judging from muffle experiments. The articles of Rockwell referred to, giving results of experiments and investigations in roasting the Yedras ore, are worth the attention of students, confirming, as they do, many of the statements of the older metallurgists, though indicating an unusually high loss of silver, both by volatilization and by insolubility, which may have been due to the peculiar character of the ore, a proof, if proof were wanting, that it will not do to generalize too widely from particular cases.

It is, however, shown by Rockwell that the Yedras ore could be roasted in the muffle in a layer so thin as not to require stirring, in a few seconds of time, to a high percentage of solubility, with no appreciable loss, and from this he draws an inference favorable to the Stetefeldt furnace above all others. I have no doubt the Stetefeldt furnace would roast that ore well, and with the minimum loss, but I doubt much if it could have roasted the balling ore with which I had to deal, containing over 20 per cent of zinc blende and a large proportion of galena, besides pyrites and native silver.

As to the loss in the reverberatory furnace at Las Yedras, which is shown to have been greater than is considered usual or allowable, it may have been caused by too great haste or too high heat in the earlier stages of the roasting, and what makes me think so is that a well known and skillful metallurgist tells me that he roasted Yedras ore in the muffle without sensible loss, using an ordinary charge, about half an inch deep, and therefore requiring to be stirred. "But," said the gentleman, "I did not hurry about it."

The roasting of ore in masses of powder, as in Brückner cylinders or reverberatory furnaces, does not admit of hurrying, but must be so carried on, by gradual increase of heat and frequent mixing, that all parts of the mass shall be as nearly as possible at the same stage of progress at any given moment, and consequently all parts shall be done at the same time, when the sooner it is removed from the furnace the better. It scarcely required the experiments and arguments of Mr. Rockwell to prove that the

retention of the roasted ore for several hours in the furnace, after it was done, caused a needless loss of silver as well as a waste of time and fuel.

I have known of a case in which 30 per cent of the silver in an ore was volatilized in the roasting with salt by too high heat in the earlier stages. Upon rectifying the error, the loss was reduced to a very low figure, and the actual yield was 91 per cent of the assay value of the ore. The volatilization of silver is a function of heat and time. In a Stetefeldt furnace the heat, though high, is of scarcely more than momentary duration, but in a reverberatory or Brückner furnace heat is necessarily applied during several hours, consequently it must be kept at a lower degree.

In regard to cylinder furnaces, whether of the Brückner or the White type, that is, whether working by charges or continuously, an important point has escaped general notice, which is this: Air of any given temperature is about half as heavy as sulphur dioxide. The cylinder furnaces are so constructed that air can only enter through the fireplace, with the result that, though it may not be all burned, or deprived of free oxygen which is essential to the roasting of a sulphuretted ore, yet it is highly heated and, consequently, being even lighter than some of the products of combustion of the fuel, it rises to the top of the cylinder where it has the least possible chance of coming in contact with the ore, that is to say, precisely where it will do the least good, while between it and the principal mass of the ore lies and sluggishly moves a stratum of sulphur dioxide and other heavy gases from the roasting ore. This effect is certainly less conspicuous in the White cylinder than in the Brückner, owing to the smaller diameter and more rapid rotation of the former, by which the ore is carried nearer to the top; yet I am convinced that an important improvement may be made in both by admitting *cold* air below the flames from the fireplace. The following extract from an article which I wrote for the "Mining and Scientific Press," in 1882, will explain my meaning perfectly, and, although written with reference to the roasting of auriferous pyrites, is equally applicable to highly sulphuretted silver ores:

"The furnace was a Brunton cylinder without lifters, and the ore was concentrated pyrites, to be roasted for treatment by chlorination. The cylinder was twelve feet long; the greater diameter, for it was egg-shaped, was six feet eight inches, and the lining was of common bricks which answered perfectly.

"The roasting proceeded with extreme slowness, not averaging more than half a ton in twenty-four hours. By inserting a wooden rod about ten feet in length through the peephole in the wall of the transverse flue, and passing it into the rear end of the furnace, it was ascertained that the slowness of the roasting was not due to any deficiency of oxygen (air) in the furnace, as the end of the stick burned readily in the upper current but was almost extinguished when depressed into the sulphurous vapor by which the lower part of the furnace was filled. * * * It was like putting the ore into a hole in the ground, and causing the flames to pass over while stirring it.

"In order to bring the ore and the air into more intimate association, and to avoid the interposing dense cloud of sulphurous vapor, a hint was taken from the action of the reverberatory furnace in which the air, entering by the open working door, can be seen to pass under the flames and directly in contact with the glowing ore. Cool air is heavier than hot sulphurous anhydride, and is transparent to radiant heat; hence, if introduced between the flame and the ore, it not only does not impede the action of the heat, but it enables the sulphur in the ore to burn, the hot product, sulphurous anhydride (dioxide), rising and admitting a fresh supply of air in contact with the ore."

In order to attain this result in the cylinder, the throat lining was removed, thus enlarging the diameter of the opening. These Brunton cylinders have no neck—and, by the way, a neck on a furnace of this class is an unmitigated nuisance; the flames should pass as directly as possible from the firebox to the interior of the cylinder, only the throat of the firebox must be lined with firebricks. The firebox was so raised as that the top of the lined throat was one inch lower than the naked iron flange of the opening in the end of the cylinder, and the throat lining of the firebox was changed from a circular form to that of a muffle. Thus a crescent-shaped portion of the circular hole in the end of the cylinder was left open for the entrance of air below the flames. The immediate result was a large increase in the roasting capacity of the furnace, and a still greater reduction in the consumption of fuel. However, for this ore it was also necessary to put in lifters. The opening described was closed, when necessary, by a piece of sheet-iron.

Of course the foregoing device was a makeshift. We could not change the cylindrical form of the firebox neck, although we did that of its lining, and this is why our air hole had the form of a crescent. In constructing a furnace with this object in view, the iron neck of the firebox would be muffle-shaped; would project only enough for convenience, say four inches, and would be lined with firebrick, projecting yet another inch. The radius of the circular part of the lined neck would be two inches less than that of the unlined, circular, flanged opening in the end of the cylinder. The firebox would simply abut against the cylinder concentrically, and, the circular part of the muffle-shaped firebox neck being of smaller radius than the hole in the cylinder, the flames would not strike the iron flange of the latter. The air hole below would have the form of a flattened D, and a cast-iron door, pivoted to the firebox neck, would close or open it as required. For a White furnace something a little different would be requisite.

As to the utility of letting the roasted silver ore lie for a number of hours in a hot pile after discharging, and before spreading to cool, it may be remarked that such a practice is necessary where a Stetefeldt or White furnace is used, and in any case can do no harm, while, although no increase of solubility can be expected if the roasting was completed in the furnace, yet, as it may sometimes occur that the possible limit of solubility has not been reached in the furnace and may be so in the pile if time be allowed, there may be a gain on the average. Moreover, the fact that the roasting can be thus completed suggests that time may be saved and the risk of overroasting avoided by this means.

The exigencies of these western countries have compelled us not only to invent new and economical mechanical devices for the roasting of silver ores, but also to attempt such roasting under conditions which would not have been admitted in Europe in the days when the Germans and others extracted silver by roasting and amalgamation, or leaching. The older metallurgists, operating on a comparatively small scale in the great metallurgical centers, having ascertained the most advantageous composition and richness of ore for the roasting always sought to attain those conditions by means of mixtures of ores and reagents, so that, having a comparatively uniform substance to treat, but little variation of treatment was necessary; also, having the advantage of very cheap labor, they were enabled to indulge in refinements of manipulation which have been and are forbidden to us. Thus it was a rule at Freiberg that an ore must yield 30 per cent of iron regulus when melted in a crucible with borax-glass, otherwise steps must be taken to supply the deficiency, or the ore could

not be chloridized. Also, the ore was submitted to two separate roastings, with an intermediate grinding. In this country we could not do these things and were obliged to do the best we could without them.

We soon found out that in many cases we could roast quite successfully ores which would yield scarcely any regulus in a crucible, and could even treat highly calcareous ores under some circumstances. We did not generally trouble ourselves much about the philosophy of the matter. Our philosophy was to try and try again, until we found out how to make the ore pay, which, after all, is the first essential in a metallurgical operation, the next being to make it pay as well as possible. Our mistakes have been great and many, and disastrous. On the whole, we have succeeded, and other nations are learning from us.

Forced to treat ores under conditions which would formerly have been considered fatal to success, we have developed new truths. We have found that ores which were formerly considered to require roasting could be worked to a profit without roasting; also we have roasted ores which would formerly have been condemned as unfit for that process. Roasting under new conditions, we have discovered new facts. It used to be considered that in an ore which had required roasting only that portion of the silver which had been converted into chloride or sulphate could be extracted by amalgamation or leaching; and in order to ascertain how great a proportion of the silver in the roasted ore (roasted with salt) was in the form of chloride, we used to make what we called a "chlorination assay," by leaching a weighed quantity of the ore with a solution of sodium thiosulphate (wrongly called hyposulphite) and assaying the residue. But various circumstances led to a doubt as to whether all of the silver thus extracted was chloride. As to sulphate of silver, that would hardly be looked for in an ore that had been roasted with salt, and as it is soluble in hot water, it would not require the solutions spoken of.

In 1876, I made some investigations which showed that the ore I was treating, which had been roasted in a Brückner furnace, contained silver compounds which were soluble in hot brine of common salt, and in solution of sodium thiosulphate, but which contained no chlorine and no silver sulphate proper, but which did contain base metal (lead, etc.) and sulphuric anhydride, and were therefore supposed to be multiple sulphates. These investigations were published in the "Mining and Scientific Press;" the old name, "chlorination assay," was discarded, and the operation was called the "solubility assay." Shortly afterward, Mr. Stewart, of the Hunt, Douglass, and Stewart process, published a similar discovery, and several years later, Mr. E. H. Russell, the inventor or discoverer of the Russell process, also discovered the fact.

At the same time I proved that lime in excess, while not preventing the reduction and amalgamation of silver in the state of chloride, did prevent that of these compounds in a pan, accounting for the fact that the use of much lime in pans, designed to prevent the amalgamation of base metal, always caused richer tailings. This fact has a parallel in Russell's discovery that caustic in the leaching solutions renders insoluble certain compounds of silver in some roasted ores, while it certainly cannot and does not have that effect on simple silver chloride. An attempt has been made, with some show of plausibility, to explain the effects of caustics in leaching by supposing that silver chloride becomes mixed, by fusion during the roasting, with lead sulphate and chloride, and the caustic decomposes these superficially, leaving a film of insoluble lead hydroxide, which impedes the extraction of the silver. To determine the correctness or otherwise of this theory in certain cases it must be ascertained whether the

insoluble substance containing silver contains also chlorine or not; in the mean time, the fact being known, the remedy is simple and obvious. If the ore contains caustic lime, as a calcareous ore is apt to after roasting, and which is known by its giving an alkaline first wash-water, it should be washed with acidulated water before the leaching. This method was practiced successfully by Mr. Henry Kearsarge, assayer, at Tombstone, Arizona, on a small working scale, prior to 1884, and that gentleman claimed that his results were equal to those of the Russell process on the same ores. It is not clear, however, that he actually understood the reason of the matter.

Caustic lime in the ore not only affects the success of the particular operation, but also, in case sodium thiosulphate is used for the leaching, as usually in the Russell process, converts a part of that into caustic soda, so that the effect is cumulative.

When Mr. Russell finds that his solution contains caustic soda, he neutralizes that by an addition of sulphuric acid.* Carbonated alkali is said not to be injurious, though why it should not be so, on the theory above mentioned, is difficult to see, as the lead carbonate as well as hydroxide is insoluble in the leaching solution; however, it may depend on the different mechanical effect of the film of carbonate.

It has been stated, by a writer on the Russell process, that when carbonated and caustic alkali are both present in the solution it is necessary to add enough of acid to neutralize both, in order to be sure of getting rid of the caustic; this seems to be an error. In the first place, chemistry affords means of testing for carbonates in presence of caustics, and *vice versa*. In the second place, if acid is added while stirring the liquid, until any further addition of even very dilute acid causes effervescence and escape of gas, all caustic is neutralized while carbonate may still remain.

Another method of neutralizing caustic is to add sodium bicarbonate until the liquid will effervesce with the slightest addition of very dilute acid, and the bubbles of gas come to the top and escape.† However, in certain cases the presence of sodium carbonate would be injurious, if not to the extraction of silver, at least to that of lead, as will be seen.

Before speaking further of the Russell process, I will briefly outline the silver leaching process, as commonly practiced heretofore.

The powdered ore is first subjected to a chloridizing roasting, in which, as nearly as may be, all of the silver is converted into silver chloride. It is usual, though not strictly necessary, to moisten the cooled ore in order to prevent dusting,‡ and it should be sifted if lumpy.

The ore is then placed in filter vats, and water is passed through it until all soluble metal salts are washed out. The first portions of the washings will contain some silver, and must be preserved for the separation of that, which may be effected in either of several ways. When the washing is completed the ore is leached by passing through it a liquid called hypo, which dissolves the chloride and several other compounds of silver, sulphate of lead, and cuprous chloride, etc. The leach is conducted into large tanks, and solution of a polysulphide is added, and mixed by stirring, until all of the dissolved silver and other metals are converted into insolu-

*An exception may be made in the case of an ore which contains much arsenic or antimony, and has been so roasted as to have formed much arsenate, etc., of silver, as these compounds dissolve more readily in a caustic solution.

† If lime is present in the solution, a precipitate will be produced by each addition of bicarbonate as long as any caustic remains. It is easy, therefore, to test a small quantity by adding a lime salt and then a little bicarbonate.

‡ The practice of cooling the red hot ore by throwing water on it is wrong, because, in many cases, a portion of the silver chloride is thus reconverted into the metallic state.

ble sulphide which is then allowed to settle. The clear liquid is drawn off and used again; the precipitate is collected on filters, washed, dried, and reduced by suitable treatment to bars of silver, which are more or less contaminated by base metals, according to the character of the ore treated and the methods used for the reduction of the precipitate.

There are two kinds of hypo, namely, sodium hypo and calcium hypo, and two polysulphides corresponding. The calcium hypo and polysulphide have been generally used, although those of sodium were first applied. The process with the calcium salts is known as the Kiss process; that with the sodium salts as the Patera process.

The Russel process is a modification of the foregoing. The roasted and washed ore is leached with sodium hypo and with cuprous hypo, which liquids have been unhappily and needlessly burdened with the awkward names of "ordinary solution" and "extra solution." The order in which the two hypos are applied, as well as their strength and temperature, depends on the character of the ore.

The chemical name of a hypo is thiosulphate; cuprous hypo is sodio cuprous thiosulphate dissolved for use in solution of sodium thiosulphate; it is made, as required for each charge of ore, by dissolving bluestone and crystallized sodium thiosulphate, in the proportion of one pound of the first to two pounds of the last, in water.

Leaving aside for the moment that branch which concerns the separation of lead from the leach, the Russell process consists essentially in the use of cuprous hypo in conjunction with the Patera process.

It is claimed, and seems to be verified in different works, that the cuprous hypo extracts in general a further quantity of silver after the sodium hypo has done all it can do. The difference is not very important when the character of the ore and the conditions of the roasting are such as to give a high degree of chloridation, because silver chloride, and even antimoniate and arsenate, are quite easily dissolved by either of the common hypos, but the cuprous hypo dissolves other silver compounds which are liable to exist, more or less, in any roasted ore, and especially when for any reason the roasting has not been as perfect as possible; and, for this very reason, a less perfect roasting is required where the cuprous hypo is used, from which, again, it is inferred that coarser crushing of the ore will answer. Moreover, some ores which will yield a greater or less portion of their silver to sodium or calcium hypo without roasting can be worked in that state to a high percentage with cuprous hypo.

Cuprous hypo dissolves metallic silver, as do also the common hypos though less rapidly; at least, this is the usual way of putting it, just as we say hypo dissolves chloride of silver, when, in fact, it decomposes chloride of silver, making sodium chloride and silver thiosulphate* which latter makes a combination with the hypo and dissolves, not as silver chloride but as silver-sodio thiosulphate which crystallizes out on evaporation. So, in the apparent solution of metallic silver in hypo, the truth is that hypo alone will not dissolve metallic silver; air or oxygen must be present, and the silver must oxidize before it can dissolve, and the hypo then becomes alkaline, just as it does when it has silver oxide, prepared beforehand, dissolved in it. A similar phenomenon occurs when gold or silver is exposed to the action of a solution of potassium cyanide with access of air, the metal is slowly dissolved.

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*That this actually takes place is neatly proved by the following experiment: A solution of sodium thiosulphate was saturated with sodium chloride. Silver chloride was then added and dissolved, and the liquid was seen to sparkle with suspended crystals, which, when settled, were found to be sodium chloride.

The usual mode of applying the cuprous hypo is to cause it to pass through the ore in the vat several times, by means of a Korting ejector, or similarly acting device, after which the liquid is passed to the precipitating tubs, and the ore is washed, first with sodium hypo, in some cases hot, and then, as usual, with water; there are cases, however, in which the cuprous hypo is allowed to stand on the ore during twelve hours; the reason of this difference is not yet known beyond the fact that the best results are got so in certain cases.

It seems that cuprous hypo acts on insoluble silver compounds in a similar manner to the copper chlorides, substituting copper for the silver in the insoluble substance, while the silver replaces copper in the liquid; hence, if not too much cuprous chloride be used, the greater part of its copper goes out of solution before the liquid goes to the precipitating tubs.

So far, there is nothing in the Russell process which need prevent the use of calcium hypo and polysulphide—that is to say, the cuprous hypo is compatible with the Kiss process, which is that generally used. Russell discovered that while either hypo extracts the lead from lead sulphate in the roasted ore, they do not dissolve lead carbonate; consequently, sodium carbonate precipitates the lead from such a solution, leaving silver and (cuprous) copper dissolved. The same discovery was made by myself, in conjunction with Mr. G. F. Beardsley, in 1882. But sodium carbonate would also precipitate lime from a calcium hypo; hence, the necessity for using the Patera process when this part of Russell's process is to be employed; although, even when sodium hypo is used, it sometimes happens that lime is present, being dissolved from the ore, and then it must contaminate the lead carbonate; in fact, the lead process is not applicable in such cases.

This part of the Russell process necessitates an extra set of precipitating tubs, in which the lead carbonate is allowed to settle, after which the liquid is transferred to other tubs in which the silver (and copper) is precipitated in the usual manner.

It is claimed that the lead carbonate obtained in this way is nearly free from silver, and otherwise pure in the absence of lime in the ore. In working the Kiss process, the lead may be thrown down by milk of lime, as hydroxide, and this is done at the Mount Cory Mill, but the product seems to be very impure and to contain much silver. It is contended by the advocates of the Kiss process that the precipitated sulphides of silver, etc., settle much better than when sodium polysulphide is used. This is denied by the other party, and I do not attach much importance to it myself. The force of the argument is probably lessened by Russell's practice of keeping his solution neutral. It is probable that the precipitate might settle badly in an alkaline solution, and the sodium hypo seems much more liable to become strongly alkaline than the calcium hypo, because of the much greater solubility of caustic soda than of caustic lime, and of the complete insolubility of calcium carbonate.

It is not easy to make sodium polysulphide quite free from caustic, at least the method of doing so seems not to have been studied by workers until Russell took it up, and, where the precipitant is caustic, the hypo becomes so necessarily, unless means are taken to counteract that effect. As this does not seem to have received much attention until recently, it may be that some of the difficulty experienced in the Patera process was due to excessive alkalinity of the solution. Certainly the less liability of the calcium hypo to becoming strongly alkaline is a point in its favor.

The choice of a hypo for practical work resolves itself into the choice of a polysulphide. We always begin with sodium hypo, because that is easily

procured, but, if we use calcium polysulphide, the sodium hypo is gradually replaced by calcium hypo through chemical reactions, which I cannot fully explain here.

One of the strongest arguments in favor of the Patera process is that the sodium polysulphide is made with the expenditure of vastly less time, labor, and fuel than the other. Also, in the use of calcium sulphide, for reasons which I must also decline entering into at present, about three times as much sulphur is consumed in recovering a given quantity of silver as when the sodium sulphide is used. The choice must of course depend mainly on the prices and purity of the substances used, but the many advantages of sodium sulphide will compensate a considerable difference to its disadvantage between the price of caustic soda and that of lime.

The reason that the sodium, or calcium hypo, can be used over again, indefinitely almost, is that although, as we have seen, it is decomposed in dissolving (and decomposing) silver chloride, it is reproduced in the precipitation of the dissolved silver by the polysulphide. Without this result the hypo would be weakened every time it was used, a portion of it being converted into silver hypo; but when the silver is removed by combination with sulphur from the sulphide, the sodium or calcium from the sulphide takes its place, thus regenerating the original hypo. But this reaction is not so simple as it has until recently been supposed to be; it is not direct, but indirect. According to the generally received view, 100 parts of caustic soda employed in making polysulphide by the process of heating with water and sulphur, which is the method employed in practice, could not under any circumstances cause the precipitation, by its combined sulphur, of more than 180 parts of silver. But in some experiments made by Russell, that gentleman got from 109 to 334 parts of silver for 100 of soda so employed, and the highest result was got with the weakest solution, a fact of which the bearing is important in the elucidation of the causes. This was at first thought to indicate that the practical coefficient of precipitation of a polysulphide had been underrated. After some experiments, in which I got similar high results, I investigated the subject with the conclusion that, when a solution of a polysulphide is added to one of silver in hypo, silver sulphide and a polythionate (most likely tetrathionate) of the base are produced, and so far 360 parts of silver (possibly more in certain cases) are precipitated as sulphide for 100 parts of caustic soda used in making the precipitant. But the instant that a polythionic salt is formed, a secondary reaction sets in, by which the polythionate and a part of the polysulphide mutually decompose, forming thiosulphate (hypo) and free sulphur. The effect is to prevent our ever getting so much as 360 of silver for 100 of soda, though we may approximate it by precipitating only a small part of the dissolved silver. Another effect is that, in several successive precipitations with equal quantities of the sulphide, we get less and less silver, until toward the last we have less than 180 parts for 100 of soda. The final result, in continued working with the same hypo is, that we get an average of just what the old theory calls for, and the supposed greater precipitating power of a polysulphide is an illusion in practice. This view explains all of the observed facts in the case, several of which are not mentioned here. It has been disputed, but not disproved, nor has any other theory been advanced which accounts for the various facts. Those who are interested in the subject will find my argument in full in the "Engineering and Mining Journal" of November 19 and 26, 1885, under the head of "Reactions of the Polysulphides."

When cuprous hypo is made by adding bluestone to sodium hypo, it is understood that, for each pound of bluestone one pound of sodium thio-

sulphate is changed into tetrathionate, and this is supposed to be lost for any useful purpose. This is not necessarily the case. All tetrathionate which finds its way to the precipitating tubs is ultimately reconverted to thiosulphate by the polysulphide. As this has been disputed—nay, even declared to be "absolutely false"—I have made some experiments to prove my view.

In 100 c.c. of water was dissolved one gram of crystallized sodium thiosulphate; a little starch was added, and then a solution of iodine in sodium iodide until the liquid was slightly blue; it was then diluted to 400 c.c. The effect of the iodine is to convert the thiosulphate into tetrathionate, as is well known. Of this solution, 20 c.c. were treated with sodium polysulphide prepared by fusion, hence containing very little thiosulphate. An immediate precipitation showed that the polysulphide was decomposed; a slight excess was added, and then a slight excess of zinc sulphate. On titration with iodine solution, of which 10 c.c. corresponded to 0.1 gram of sodium tetrathionate, it required 5.4 c.c. of the iodine solution to blue the liquid (starch being present). In a second experiment, with 10 c.c. regenerated in the same way, 2.6 c.c. of iodine solution were consumed. A test for alkali sulphites resulted negatively; hence the figures show that all of the thiosulphate was regenerated, and there was a slight excess due to the polysulphide. Again, 10 c.c. were regenerated, and silver chloride was added to the filtered liquid; the first effect was the conversion of the chloride to iodide by the sodium iodide present; this was filtered off and another quantity of silver chloride added and mixed with the liquid; a notable quantity was dissolved, as proved by filtering, precipitating with sulphide and digesting the precipitate with aqua regia and potassium chlorate. Another 10 c.c. was regenerated, and a part tested for sulphite, which was not found; another part, tested for thiosulphate gave the proper reactions. The unregenerated solution was incapable of dissolving more than a trace of silver chloride, but it converted that into silver tetrathionate, losing nearly all of its alkali tetrathionate. This would not take place in presence of an excess of hypo, so that there is no danger from the presence of tetrathionate in the working hypo.

The inference of the reproduction of thiosulphate is irresistible. But I went further. Eleven grams of sodium thiosulphate and six grams of copper sulphate were separately dissolved in as little cold water as possible. (The temperature of the laboratory was between 70 degrees and 80 degrees Fahrenheit.) The saturated solutions were mixed, and the resulting yellow precipitate was filtered out. The liquid retained very little copper, and it had an acid reaction on litmus paper; it was diluted to about 300 c.c. I regret that I did not dilute to an accurately measured quantity, also that I did not wash the yellow salt. The fact is, this experiment preceded that just described, and I did not at first intend to make it strictly quantitative; however, the results are conclusive as to the practical point. This solution, tested for sulphite, showed a trace of that; probably it was an impurity in the sodium salt used. It also showed the presence of a little thiosulphate, and 10 c.c., with starch paste, required 0.25 c.c. of iodine to blue it. Another 10 c.c., diluted to 50 c.c., treated with the polysulphide, short of excess, required 17.8 c.c. of iodine. Another 10 c.c., treated with slight excess of sulphide, and then slight excess of lead acetate, and a drop of acetic acid, took 16.4 c.c. of iodine. Yet another 10 c.c., with slight excess of sulphide, and then excess of zinc chloride, required 18.3 c.c. of iodine. Ten c.c., similarly regenerated, dissolved 81 milligrams of silver chloride, and a second trial gave 80 milligrams, besides a little lost by spurting. The quantity of the polysulphide used in regenerating 10 c.c. of the solution,

after treatment with a slight excess of zinc sulphate solution, took 0.3 c.c. of iodine to strike a blue color with starch. The regenerated solution gave the proper reactions for thiosulphate; tested for sulphite, it showed a trace, even weaker, apparently, than the unregenerated liquid.

The unavoidable inference is that sodium tetrathionate produced in making the cuprous hypo is reconverted into thiosulphate (sodium hypo) in the precipitating tubs, at the expense of the polysulphide.

As regards the practical results of the Russell process compared with those of the older methods, having had no opportunity of personal observation, I can only give some of the published statements of parties who may be more or less interested in its adoption.

In a paper on the subject presented to the American Institute of Mining Engineers, in February of the present year, by Ellsworth Daggett, it is stated (page 57) that "charges were selected having tailings of 20 to 40 ounces per ton after the ordinary solution had done its utmost work and had failed to further lower the value of the tailings. The extra solution was then used on these charges. * * * The results showed that the use of 6½ to 8 pounds of bluestone per ton increased the average mill extraction by 12.2 ounces per ton of ore, which is equivalent to 1.68 troy ounces of silver for each avoirdupois pound of bluestone."

My comment on this is, that there must have been something radically wrong when the leaching by sodium hypo left so much in the tailings, and that the final result, admitting an average value of the sodium hypo tailings of 30 ounces per ton, and an average further extraction, by cuprous hypo, of 12.2 ounces, still leaving 17.8 ounces in the final tailings, was not a brilliant success from a practical point of view, unless, indeed, the ore had been very rich at first, of which we are not informed. Reading further, we find that "at the Ontario, the additional extraction caused by the use of two charges of extra-solution of 9½ pounds each of bluestone was an extraction of 39.1 per cent of 88 ounces ore, more than could be extracted by the ordinary solution in either the mill or the assay office. This is an additional extraction of 34.4 ounces per ton, * * * or 1.81 ounces of silver per pound of bluestone." It is not stated how much silver remained in the tailings at last, but evidently the solubility in sodium hypo was low, indicating poor roasting in the first place or a bad condition of the hypo

On page 58, after a table which is not necessary to notice here, as it refers exclusively to the work at the Cusi Mine, where it appears that the process was abandoned in favor of the Kiss process early in this year, the author says: "At the Ontario, when allowed to act on tailings from the ordinary solution but very high in value, or in other words, when allowed to show its utmost efficiency, the amount of silver extracted by the extra-solution was in value about fifteen times its entire cost, including chemicals, preparation, and application, and the precipitation of the metals from it." A result which was certainly much better than throwing such rich tailings away, yet suggesting that the ore might have been much better treated in the first place, or the tailings might have been roasted over again. However, these experiments are interesting as showing what the cuprous hypo can do in case of need, and it is well to make the acquaintance of so competent an ally.

In addition to the use of cuprous hypo for the extraction of silver, and of sodium carbonate for the separation of lead, the Russell process people claim the neutralizing of an alkaline hypo by an acid. The washing of the ore with acidulated water, as practiced by Kearsarge, although efficient in neutralizing the effect of lime in the roasted ore, and otherwise

beneficial, would not forestall or correct the injurious effect of caustic introduced to the hypo by the previous use of sodium sulphide containing caustic soda, a contamination very likely to occur. There are several ways in which this caustic may be neutralized, otherwise than by the addition of sulphuric acid, and which are covered by Russell's patents.

Under the heading of "*Comparison with the Ordinary Leaching Process,*" on page 113, etc., Mr. Daggett gives the following interesting and instructive statements:

"*At the Ontario Mill, Park City, Utah.*—The results of these experiments, Table XXXII, illustrate, not only the greater extraction of silver by the 'extra-solution,' but also the injurious effect of caustic alkali entering the ordinary solution from the precipitant, and show separately the beneficial effects of the use of acid and of bluestone, which constitute the important chemicals peculiar to the Russell process. In these tests, which were made on a scale of two to three tons each, the first wash-water being acid, the caustic alkali could not have entered the solution from any other source than the precipitant. The first set of experiments in Table XXXII shows an assay office extraction, by ordinary solution, of 89.0 per cent; but a mill extraction, by ordinary solution, of 81.8 per cent. Samples of the mill tailings were then leached in the assay office with ordinary solution, which brought the extraction up to 82.8 per cent, instead of 89.0 per cent, as it would have been if some of the silver which had originally been soluble in ordinary solution had not been rendered insoluble during the leaching in the mill. This insoluble percentage was 6.2 per cent of the value of the ore.

"During the next four tests, in Table XXXII, the caustic alkali in the stock-solution had increased to such an extent as to cause the mill-extraction to fall to 66.2 per cent, or 18.1 per cent below the extraction by ordinary solution in the assay office. By leaching samples of these tailings in the assay office, this was raised to 69.7 per cent, which still left 14.6 per cent discrepancy, the amount of silver rendered insoluble during the leaching in the mill. Up to this time no part of the Russell process had been used."

I here interrupt the quotation to remark that had the Kiss process been used, it is not likely that the hypo would have been so strongly alkaline, as the calcium polysulphide can contain but very little caustic, and the Kiss process *is* the "ordinary leaching process;" so that the comparison is not a just one, however instructive as to the Patera process. To return to Mr. Daggett:

"The whole stock-solution was now rendered neutral by the addition of sulphuric acid, the amount of acid used to neutralize all caustic alkali which had so far accumulated being 0.1 per cent by weight of the stock-solution. Always afterward the stock-solution was kept neutral by the addition of acid to the extent of three fourths to one pound per ton of ore treated. For the next ten tests after the neutralizing of the caustic alkali and the use of one pound of acid per ton, the extraction in the mill by ordinary solution varied from the ordinary in the assay office only 0.1 per cent. By comparing these figures with the preceding, it will be seen that the use of an amount of acid costing only three to four cents per ton of ore has raised the mill-extraction thirteen to fifteen ounces per ton. But the mill-results, although equal to the ordinary in the assay office, were 7.5 per cent lower than by the 'extra' in the assay office. The 'extra-solution' was then used in the mill in addition to the acid with the results shown in the last line of the table. Comparing this with the second line of figures, we see that the Russell process (both acid and 'extra-solution')

made a difference in the mill of 26.2 per cent, which, on 86.5 ounces of ore, is 22.6 ounces per ton."

Following is the table referred to:

TABLE XXXII. (From Daggett's Paper.)

Comparison of the Russell Process with the Old or Ordinary Leaching Process at the Ontario Mill in 1883-4.

Acid Roasted Ore.

Value of Ore, Ounces Silver per Ton.	Per Cent Extracted by Ordinary Solution in Assay Office.	Per Cent Extracted by Extra-Solution in Assay Office.	Per Cent Extracted in Mill.	Per Cent of Silver Made Insoluble in Ordinary Solution by Caustic Alkali.	Difference Between Extraction in Mill and Extraction in Assay Office, per Cent.
Average Results of the First Four Mill tests with the Ordinary Process. (Neither Acid nor "Extra-Solution" was Used in Mill.)					
85.0	89.0	90.5	81.8	6.2	8.7
Average Results of the Second Four Mill tests with the Ordinary Mill Process. (Neither Acid nor "Extra-Solution" was Used in Mill.)					
86.5	84.3	92.5	66.2	14.6	26.3
Average Results of the Next Ten Mill tests, in which Acid was Used in Mill, but no "Extra-Solution."					
90.4	82.6	90.0	82.5	0.0	7.5
Average Results of Subsequent Mill tests in which both Acid and "Extra-Solution" were Used in Mill.					
72.0	87.0	92.6	92.5	0.0	0.1

In working raw tailings already amalgamated and once concentrated, at Silver City, Mew Mexico, as stated by Daggett, page 115, the material assaying 11.6 ounces of silver per ton, the ordinary leaching process gave 38 per cent, and the Russell process gave 61.7 per cent of the assay value. Again, at Lake Valley, New Mexico, a calcareous roasted ore yielded in the mill as follows: By amalgamation, 70.6 per cent; by ordinary leaching, 53 per cent; by Russell process, 83 per cent of the assay value. At Sombrerete, in Mexico, the results, by Russell process in a set of working tests on charges of from three hundred and twenty-five pounds to four and one half tons of ore, were 22.6 per cent of the assay value higher than by the old process of leaching. It is not clear in these tests whether the Patera or the Kiss process was used for comparison; if the former, and the sodium polysulphide was allowed to contain caustic soda, the comparison is not fair to the Kiss process.

Similar results are shown to have been obtained at the Cusi Mill, where special mill runs were made for the purpose of tests; the Russell process extracted from 22 to 24 per cent of the value more than the old process. Metallurgists, while not denying some merit to the Russell process, will scarcely admit that justice was done to "the old process." At the Yedras Mill, also in Mexico, with an "alkaline arsenical" ore, the mill tests by the Russell process gave an average of 9.37 ounces per ton more than the old process, which, after deducting the extra cost, leaves a net profit of $7 80 per ton above that of the old method.

Many other examples are given by Daggett to show the superiority of the Russell process, but those quoted will suffice to show what is claimed for the new method. The Russell process was abandoned at the Cusi Mill immediately on a change of Superintendent of that mine early in 1888. At Bullionville, the process was applied to tailings which seem to have been too finely ground for any leaching process. This material could be made leachable, in a mechanical sense, by roasting, but it was of such a character that it could not be chloridized to a high percentage, and the cuprous hypo failed to remedy the defect, that is, the Russell process failed, in this instance, in doing just what it is claimed to do. At Lake Valley the work was not long continued, the failure being ascribed to the faulty construction of the plant. A great success seems to have been made at Las Yedras, and the Sombrerete new mill is to have the process.

The Russell process has been in existence only four years, which is but a short time for the introduction of an important change certain to be opposed by many through a simple dislike for change, or from a disinclination to being compelled to learn their business over again, and the feeling is perhaps not lessened by the fact that the process has been discovered by a gentleman who was previously unknown to fame. As an impartial and disinterested observer, while I admit that the merits of the method have probably been exaggerated by enthusiasts and interested persons, and even that they appear to have, in some cases, *created* a necessity for it by the use of sodium polysulphide containing caustic soda, and by needlessly defective roasting, yet I believe the process has a practical value in certain cases, and it has undoubtedly given a great impulse to the study of the facts and principles of silver leaching, and has led to a number of important improvements in the plant.

I strongly recommend Calico, in San Bernardino, as a probable field for the application of the Russell process to raw ores, some of which have already been profitably treated on a small scale by the Kiss process.

Since writing the foregoing, Mr. Russell has kindly sent me the appended tabulated statements of results recently obtained from various ores; if these results are verified in practice, it would seem that amalgamation of auriferous silver ores will soon be abandoned.

GOULD AND CURRY ORE.

Virginia City, Nevada.

Details of Results of Roasting and Leaching Tests at the Ontario Mill, Park City, Utah.

Method of Leaching.	First Method of Roasting.		Second Method of Roasting.		Third Method of Roasting.		Fourth Method of Roasting.		Fifth Method of Roasting.		Average by Each Leaching Method.	
	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Silver.	Gold.
First	88.0		86.0	75.0	88.9		87.9	90.0	86.3	87.5	87.4	84.1
			80.5				**89.0**		**86.8**			
Second	88.0	75.1	80.0	80.0	88.9	98.5	88.6	98.6	93.8	70.0	87.9	86.8
			80.0		**93.7**		**93.6**		**81.9**			
Third	90.1		78.0	85.0	83.3	85.0	88.7	98.6	89.8	81.0	85.9	87.4
			81.5		**84.1**		**93.6**		**85.2**			
Average by each roasting method	88.7	75.1	81.3	80.0	87.0	91.7	88.4	95.7	89.8	79.5	87.1	86.1
	81.8		**80.6**		**89.3**		**92.0**		**84.6**		**86.6**	

Summary of Results of Roasting and Leaching Tests.

Best roasting and leaching methods for silver alone:
- Fifth method of roasting and third method of leaching extracts 89.8 per cent of the silver.
- First method of roasting and third method of leaching extracts 90.1 per cent of the silver.
- Fifth method of roasting and second method of leaching extracts 93.8 per cent of the silver.

Best roasting and leaching methods for gold alone:
- Fourth method of roasting and second method of leaching extracts 98.6 per cent of the gold.
- Fourth method of roasting and third method of leaching extracts 98.6 per cent of the gold.
- Third method of roasting and second method of leaching extracts 98.5 per cent of the gold.

Best roasting and leaching methods for both gold and silver, if the ore is of the same value in each:
- Third method of roasting and second method of leaching extracts 88.9 per cent of the silver and 98.5 per cent of the gold.
- Fourth method of roasting and second method of leaching extracts 88.6 per cent of the silver and 98.6 per cent of the gold.
- Fourth method of roasting and third method of leaching extracts 88.7 per cent of the silver and 98.6 per cent of the gold.

Best roasting and leaching methods for both silver and gold, for ore assaying 20.0 ounces silver and .4 ounces gold:
- Third method of roasting and second method of leaching extracts 88.9 per cent of the silver and 98.5 per cent of the gold—$25 60.
- Fourth method of roasting and third method of leaching extracts 88.7 per cent of the silver and 98.6 per cent of the gold—$25 60.
- Fifth method of roasting and second method of leaching extracts 93.8 per cent of the silver and 70.0 per cent of the gold—$24 30.

Assay of samples tested: Silver, 19.8 ounces; gold, .40 ounce. Silver is estimated at $1 per ounce, gold at $20 per ounce.

OCCIDENTAL ORE.

Details of Results of Roasting and Leaching Tests at Ontario Mill, Park City, Utah.

Method of Leaching.	First Method of Roasting.		Second Method of Roasting.		Third Method of Roasting.		Fourth Method of Roasting.		Fifth Method of Roasting.		Average by Each Leaching Method.	
	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Per Cent of Silver Extracted.	Per Cent of Gold Extracted.	Silver.	Gold.
First	95.4		87.6	81.6	92.6	78.5	91.7	67.7	92.6	66.0	91.6	73.4
			84.6		**85.5**		**79.7**		**79.3**		**82.5**	
Second	98.7	49.8	88.5	90.9	93.9	81.5	91.7	60.0	94.2	81.6	93.4	78.8
			89.7		**87.7**		**75.8**		**87.9**		**86.1**	
Third	91.0		87.6	99.0	90.0	72.0	90.0	75.4	92.0	71.0	89.7	79.3
			93.3		**81.0**		**82.7**		**81.5**		**84.5**	
Average by each roasting method	95.0	49.8	87.9	90.5	92.2	77.3	91.1	67.7	93.0	72.9	91.6	77.2
	72.5		**89.2**		**84.7**		**79.4**		**82.9**		**84.4**	

Summary of Results of Roasting and Leaching Tests.

Best roasting and leaching methods for silver alone:
- First method of roasting and second method of leaching extracts 98.7 per cent of the silver.
- First method of roasting and first method of leaching extracts 95.4 per cent of the silver.
- Fifth method of roasting and second method of leaching extracts 94.2 per cent of the silver.

Best roasting and leaching methods for gold alone:
- Second method of roasting and third method of leaching extracts 99.0 per cent of the gold.
- Second method of roasting and second method of leaching extracts 90.9 per cent of the gold.
- Fifth method of roasting and second method of leaching extracts 81.6 per cent of the gold.

Best roasting and leaching methods for both silver and gold, if the ore is of the same value in each:
- Second method of roasting and third method of leaching extracts 87.6 per cent of the silver and 99.0 per cent of the gold.
- Second method of roasting and second method of leaching extracts 88.5 per cent of the silver and 90.9 per cent of the gold.
- Third method of roasting and second method of leaching extracts 93.9 per cent of the silver and 81.5 per cent of the gold.

Best roasting and leaching methods for both silver and gold, for ore assaying 20 ounces silver and .65 ounce gold:
- Second method of roasting and third method of leaching extracts 87.6 per cent of the silver and 99.0 per cent of the gold—$29 40.
- Fifth method of roasting and second method of leaching extracts 94.2 per cent of the silver and 81.6 per cent of the gold—$28 60.
- Third method of roasting and second method of leaching extracts 93.9 per cent of the silver and 81.5 per cent of the gold—$28 50.

Assay of sample tested: Silver, 20.2 ounces; gold, .65 ounce. Silver is estimated at $1 per ounce, gold at $20 per ounce.

ASPEN ORE—DETAILS OF METHODS AND RESULTS OF RAW AND ROASTING-LEACHING TESTS. ONTARIO MILL, PARK CITY, UTAH.

Value of Ore and Results of Raw Leaching Tests.

Ounces of Silver per Ton.	Per Cent of Lead.	Per Cent by Method No. 1.	Per Cent by Method No. 3.	Per Cent by Method No. 4.	Per Cent by Method No. 5.	Per Cent by Method No. 6.	Per Cent by Method No. 7.
41.2	6.0	84.5	82.1	77.2	85.2	70.2	81.1

Description of Roasting Tests.

	Method No. 1.	Method No. 2.	Method No. 3.	Method No. 4.	Method No. 5.	Method No. 6.	Method No. 7.	Method No. 8.
Per cent of salt	10	10	10	10	10	5	5	5
Per cent of sulphur		2		1		1		
Per cent of iron matte			2		1		1	

Details of Results of Roasting-Leaching Tests.

METHOD OF LEACHING USED.	First Method of Roasting.	Second Method of Roasting.	Third Method of Roasting.	Fourth Method of Roasting.	Fifth Method of Roasting.	Sixth Method of Roasting.	Seventh Method of Roasting.	Eighth Method of Roasting.
	Per Cent of Silver Extracted.	Per Cent of Silver Extracted.	Per Cent of Silver Extracted.	Per Cent of Silver Extracted.	Per Cent of Silver Extracted.	Per Cent of Silver Extracted.	Per Cent of Silver Extracted.	Per Cent of Silver Extracted.
Second	85.0	91.0	85.7	88.4	82.3	70.2	77.5	73.9
Third	90.0	92.4	91.2	94.5	85.9	77.8	82.0	79.3
Eighth	92.5	93.4	93.4	96.0	91.6	81.3	83.0	82.5

Summary.

Best raw leaching methods and the results:
- Fifth method of leaching extracts 85.2 per cent=35.1 ounces.
- First method of leaching extracts 84.5 per cent=34.8 ounces.
- Third method of leaching extracts 82.1 per cent=33.8 ounces.
- Seventh method of leaching extracts 81.1 per cent=33.4 ounces.

Best roasting-leaching methods and the results:
- Fourth method of roasting and eighth method of leaching extracts 96.0 per cent=39.5 ounces.
- Fourth method of roasting and third method of leaching extracts 94.5 per cent=38.9 ounces.
- Second and third methods of roasting and eighth method of leaching extracts 93.4 per cent=38.4 ounces.

THE RUSSELL PROCESS VS. AMALGAMATION.

Comparative Mill Runs at Ontario Mill for Eight Months.

Mill runs on ore crushed through a twenty-six-mesh screen and roasted for amalgamation:

MONTHS.	Rate of Roasting per Furnace in Tons per Day	Ounces per Ton in Roasted Ore	Ounces per Ton in Tailings, from Amalgamation	Ounces per Ton in Tailings, from Russell Process	Per Cent Extracted by Amalgamation	Per Cent Extracted by Russell Process	Ounces per Ton in Favor of Russell Process	Per Cent in favor of Russell Process
November	40.0	42.7	8.8	3.9	79.4	91.0	4.9	11.6
December	41.5	44.6	6.7	3.4	84.9	93.4	3.3	8.5
January	38.0	42.9	9.9	2.9	77.0	93.1	7.0	16.1
February	41.5	44.0	11.7	2.6	73.5	93.9	9.1	20.4
March	38.0	46.1	9.4	3.4	79.7	92.6	6.0	12.9
April	40.0	52.7	12.3	5.3	76.6	90.0	7.0	13.4
May	40.0	54.0	18.7	8.3	65.3	84.7	10.4	19.4
June	38.0	49.5	8.6	4.6	82.7	90.7	4.0	8.0

The Russell process on ore crushed too coarsely for amalgamation. Ten-mesh screen.

August	70.0	42.6	....	4.0	....	90.7	....	....
September	94.0	47.3	....	3.1	....	93.4	....	....

NOTE.—A coarser than a twenty-six-mesh screen cannot be used for amalgamation.

RUSSELL PROCESS SULPHIDES VS. AMALGAMATION BULLION—COMPARISON OF FREIGHT, COMMISSION, AND REFINING CHARGES.

Yedras Sulphides Shipped from New York to Aurora, Illinois.

Commission and refining charges, per ounce	$2 00
Freight	31
Total discount from New York quotations	$2 31

Yedras Sulphides Shipped from New York to Newark, New Jersey.

Commission and refining charges, per ounce	$1 62
Freight	31
Total discount from New York quotations	$1 93

Ontario Bullion.

Commission and refining charges, per ounce	$1 72
Freight	2 41
Total discount from New York quotations	$4 13

Daly Bullion.

Commissions and refining charges, per ounce	$1 17
Freight	1 23
Total discount from New York quotations	$2 40

NOTE.—Yedras sulphides average 550 fine, or 16,000 ounces per ton; Ontario bullion averages 457 fine; Daly bullion averages 894 fine.

THE STETEFELDT FURNACE ON ONTARIO ORE.

Relation of Tons Roasted per day and Mesh of Screen to Results by Russell Process and Amalgamation.

Mesh and Size of Wire.	Tons Crushed per day by 20 Stamps.	Per cent of Salt in Roasting.	Tons Roasted per day by One Furnace.	Per cent Extracted by Amalgamation.	Per cent Extracted by Lixiviation.
26-M., 32-W	40	16	40	89.2	93.6
16-M., 26-W	70	12	70	Too coarse for	97.1
10-M., 23-W	94	14	94	Amalgamati'n.	93.4
6-M., 20-W	....	....	....	....	....

NOTE.—By more recent advices from Mr. Russell I learn that he is crushing one hundred and twenty-six tons of Ontario ore per day through a six-mesh sieve, roasting the same in a Stetefeldt furnace, and extracting 91.8 per cent of the value by leaching.

ERRATA.

Page 865, lines 22 to 26 from top, read barrels.

Page 865, line 26 from top, read 330,853 barrels.

Page 869, line 13 from top, read barrels in place of pounds.

Page 869, line 33 from top, read three in place of four.

Page 878, line 27 from top, read had in place of have.

NATURAL AND ARTIFICIAL CEMENT.

NATURAL.

The State of California possesses within its boundaries all the ingredients necessary to produce both natural and artificial hydraulic cement, and yet we continue to neglect the advantages that would accrue to the State from home production, and send away to England, Germany, and Belgium annually hundreds of thousands of dollars.

Last year (1887) there was imported from Europe over three hundred and twenty-five thousand barrels, which cost in Europe from $1 21 to $1 60 per barrel. At $1 60 it amounted to $520,000. Freight averages from 75 cents to $1 10 per barrel. At the lowest figure it would be $243,-750. Insurance and foreign commissions amount to about 1 per cent, or $5,200. The money which has been taken from trade, left California and the country, on this one article, during the year, is about as follows:

Cost of cement in Europe	$520,000
Freight	243,750
Insurance and commissions	5,200
Total	$768,950

For which amount our own local interests have suffered, in paying foreign capital for an article which we are competent to make and have vast amounts of the raw material within our own boundaries. To show how the uses of cements have increased, the following amounts imported for the last fifteen years will be suggestive:

1873	61,911 pounds.	1878	57,258 pounds.	1883	151,807 pounds.
1874	79,435 pounds.	1879	55,668 pounds.	1884	52,500 pounds.
1875	73,814 pounds.	1880	62,417 pounds.	1885	66,433 pounds.
1876	66,988 pounds.	1881	65,695 pounds.	1886	159,000 pounds.
1877	67,800 pounds.	1882	99,208 pounds.	1887	303,853 pounds.

WHAT CONSTITUTES HYDRAULIC CEMENT.

It has been proven that limestones containing a certain amount of clays have, when burned and ground, the power of setting without swelling or contracting—*i. e.*, a chemical decomposition has resulted from the burning; when the powder is combined with water, a rearrangement of the atoms, crystallizing, forming a mineral which has the power of being absorbed and absorbing portions of the materials to which it is applied, and by age becomes harder than the materials to which it is attached.

The Romans were the first to take advantage of this natural law. The materials they used were burned limestone, containing small amounts of clays, mixed with a ground and dry volcanic ash called "pozzuolana," a hydrous silicate which is nearly all soluble in dilute mineral acids. The process of manipulation was as follows: The freshly burned lime was moistened with water till it slacked, then sifted to remove all coarse and unburned particles. After standing twenty-four hours sufficient water was added to make a thick paste and to thoroughly hydrate all the lime then the pozzuolana and sand were thoroughly incorporated.

The art of making this mortar was lost to Western Europe from A. D. 300 till Smeaton, in experimenting for mortars to construct the Eddystone lighthouse, used pozzuolana and limestones containing small percentages of clays. The analysis of pozzuolana differs so much that it is impossible to give all the analyses of those that have been used. The following is one from Rome, Italy:

Silica	44.5
Alumina	15.0
Iron peroxide	12.0
Lime	8.8
Magnesia	4.7
Soda	4.1
Water	9.2
	98.3

To make a Roman mortar: To each one hundred pounds of the above pozzuolana it would require about ninety pounds of anhydrous pure lime; but as no lime is pure, and a small percentage of clay is advantageous to the mortar, a lime containing about 15 per cent of clay is generally used. Of this lime about one hundred and ten pounds would be required.

In California there are certain clays which, when gently burned, have the power, when combined with freshly slacked lime, of setting slowly and attaining great hardness. At the time Smeaton was experimenting on mortars, others, both in England and France, were making researches in other directions, and as a result of their efforts we have Portland cement.

Some time prior to Smeaton's there had been made in England a natural cement from limy nodules containing clays, called "septaria," which were washed out of the clay bluffs by the action of the sea. This material was slightly burned to expel carbonic acid, and then ground. This they termed "Roman cement," supposing it to be the same class of material which the Romans made use of in their wonderful engineering achievements. The English "Roman cement" is quick setting, and does not attain great tensile strength, which is due to an insufficient quantity of lime to qualify all the ingredients. It was through its agency, however, that the then wonderful achievement of constructing the tunnel under the Thames was successfully accomplished.

ANALYSES OF SEPTARIA FROM WHICH THE ENGLISH NATURAL "ROMAN" CEMENTS ARE MADE.*

	1.	2.	3.	4.
Carbonic acid	34.30	31.00	29.00	22.75
Silica	8.80	18.00	17.75	9.38
Alumina	3.40	----------	----------	----------
Iron	10.20	5.25	6.00	17.73
Lime	30.24	30.20	35.00	29.25
Magnesia	6.76	.20	.50	----------
Alkalies	4.20	5.60	----------	7.50
Water	2.00	----------	3.00	4.00
Manganese	----------	6.75	1.00	----------
Totals	99.90	96.90	92.25	90.61

No. 1—Calderwood, Scotland, Roman cement, raw. No. 2—Sheppy, England. No. 3—Sheppy, England. No. 4—Sheppy, England.

If the limestones contain too great an excess of clays the resulting cement will be quick setting, soon attaining its maximum hardness.

* Analyses from "Gilmore on Lime and Cement."

Such cements have but limited tensile strength and by age deteriorate. In burning such stone a heat hardly sufficient to drive off the carbonic acid can be used; if greater, a slag is the product. If the limestone contains an excess of the requisite lime to clay a greater heat is required, and when such cement is used it swells, and if water is allowed to act upon it *in situ*, the free lime hydrate washes out, thus weakening the mortar. What is required is a stone in which the lime and clays are in such proportion that when burned they will chemically react on each other, forming silicates and aluminates of lime. Such a natural combination is seldom found, but those approaching it are of common occurrence and particularly so in this State. Such material can be burned to the verge of vitrification and the resulting powder is dense and attains increased tensile strength by such burning.

The natural cement stones in the Eastern States are usually in strata, each layer having a different composition. It is the aim of the producer to make a cement of unchanging character, and of such a composition that the clays and lime or lime with magnesia are in correct proportion, which they attempt to attain by combining two or more of the strata and burning together at as great a heat as possible.

The following analyses are of some of the limestones used by different manufacturers:

	1A.	2A.	3A.	4A.	5A.
Silica and clay	24.74	27.10	24.20	19.64	17.84
Alumina	16.74	1.50	6.16	7.52	4.00
Peroxide of iron	6.00	....	2.02	2.38	1.70
Carbonate of lime	41.80	65.50	56.84	30.72	58.25
Magnesia	4.10	5.30	10.38	35.10	11.10
Alkaline salts	6.18	.30	1.50	4.10	3.20
Totals	99.56	99.70	101.10	99.46	96.09

The resulting cements from above would have the following composition:

	1Aa.	2Aa.	3Aa.	4Aa.	5Aa.
Silica and clay	30.47	39.79	32.22	29.94	28.19
Alumina	20.62	2.20	7.87	11.46	6.32
Peroxide of iron	7.39	....	2.57	3.63	2.68
Lime	28.84	53.89	42.13	26.20	51.56
Magnesia	5.05	3.67	13.27	25.47	8.56
Alkalies	7.61	0.44	1.94	3.30	2.67
Totals	99.98	99.99	100.00	100.00	99.98

The cements Nos. 1Aa, 2Aa, 3Aa, and 4Aa have a deficiency of lime. As the deficiency predominates, so the cements are light in weight, quick setting, and do not attain any degree of hardness and strength. A cement like No. 1Aa would be very difficult to use as a mortar. No. 2Aa is much superior to No. 1Aa. Nos. 3Aa and 4Aa are the best and make good cements without any admixture. No. 5Aa has an excess of the lime element. When freshly ground and mixed with water it would not set, but slack till all the free lime is hydrated, the pasty mass in water would after a time begin to harden and eventually attain considerable strength; such a cement should not be barreled immediately from the stone, as could be done with Nos. 1Aa, 2Aa, 3Aa, and 4Aa, but after burning should

be allowed to stand in heaps for a short period of time before grinding, and after grinding spread on floors till the excess of free lime has become neutralized, and then barreled.

Calculation shows that to make up the deficiency in lime in the raw materials Nos. 1A, 2A, 3A, 4A, and to counteract the excess in No. 5A, it would be necessary to add to each one hundred pounds of the cement stone carbonate of lime as follows: To No. 1A, 73.44 pounds; to No. 2A, 21.88 pounds; to No. 3A, 11.91 pounds; to No. 4A, 10.17 pounds; and deducting from No. 5A, 3.88 pounds of carbonate of magnesia.

The analyses of the stones would then be as follows:

	1Aa′.	2Aa′.	3Aa′.	4Aa′.	5Aa′.
Silica and clay	14.30	22.30	21.74	17.91	19.34
Alumina	9.68	1.23	5.31	6.86	4.34
Iron peroxide	3.46		1.74	2.17	1.84
Carbonate of lime	66.62	71.85	60.98	37.30	63.18
Carbonate of magnesia	2.36	4.36	8.95	32 02	7.83
Alkalies	3.57	.24	1.27	3.74	3.47
Totals	99.99	99.98	99.99	100.00	100.00

The resulting cement after the assumed admixtures would result as follows:

	1Aa″.	2Aa″.	3Aa″.	4Aa″.	5 Aa″.
Silica and clay	20.23	33.75	29.67	27.53	29.08
Alumina	13.70	1.86	7.52	10.55	6.52
Iron peroxide	4.89		2.35	3.32	2.77
Lime	52.78	60.88	46.47	32.12	53.20
Magnesia	3.34	3.15	12.23	23.46	5.61
Alkalies	5.05	.36	1.76	3.02	2.81

To show that lime and magnesia can replace each other to a certain extent, take analysis 4Aa″ and, replacing magnesia with equivalents of lime, the results give a much more dense cement, and corresponds closely to the analysis of a good Portland cement.

	4Aa″	4Aa‴
Silica and clay	27.53	25.16
Alumina	10.55	9.64
Iron	3.32	3.03
Lime	32.12	59.40
Magnesia	23.46	......
Alkalies	3.02	2.76
Totals	100.00	100.00

In burning these raw materials a difference will be noted. To No. 1A hardly sufficient heat can be used to expel all the carbonic acid; the minute it is gone the stone will commence to slag, if there is any increase in heat. No. 2A would require greater heat than No. 1A. The heat could be increased up to No. 5A, which would require about the same heat as the best qualities of Portland cement. The best article would be made by combining Nos. 3A and 5A in about equal proportions, having No. 5A in

finer pieces than No. 3A. After the cement is ground it should be spread on floors until the excess of free lime is neutralized, then be immediately barreled.

The plant requisite to manufacture natural cement is of simple construction. The buildings consist of a mill and cooper shop. The kilns are similar to lime kilns, but generally much larger. The mill, preferably situated on a sidehill, is best described by stating that it is practically a combination of a quartz and a flour mill; it has the rock breakers and rolls of a quartz mill, with the stones and packing appliances of the flour mill. The burned rock should come in at the top of the mill, to save handling, and be conveyed by spouts through its various gradings into the packing machine or barrel.

A mill to reduce one hundred pounds of burned rock to powder will consist of one rock breaker, one set of rolls, and two sets of stones. The capacity of one set of four-foot stones is about sixty barrels per day, in ten hours. This plant would require about sixty-horse power. The cement, when ground, should be of such a fineness that 95 per cent will pass through a sixty-mesh screen.

The kilns are about thirty feet high, of cylindrical form: at the top, nine feet in diameter; three feet down, eight feet six inches in diameter, then widening at twenty feet to nine feet six inches, then contracting for the next seven feet till top of pit is reached to three feet. The discharge is three feet high by two feet six inches wide. The kiln is lined for the first twelve feet from the top with firebrick, the remaining distance with well-burned common brick. Coke, anthracite, or semi-bituminous coal, can be used.

THE METHOD OF BURNING.

The kiln is fired up by placing about three feet of cordwood in the lower portion of the kiln. Overlying the wood a thick layer of rock is placed for about a foot, then a thin layer of coarse coal, and from there up alternate layers of coal and rock. This coal or coke should be broken up quite fine. One ton of coal will (after the kiln is running smoothly) burn about thirteen tons of stone, or from fifty-five to fifty-seven barrels of four hundred pounds each. The size of the stone should not be over six inches the longest way and from that size down. The kiln is drawn out at the bottom twice every twenty-four hours, raw stone and coal being added on top after each drawing. Natural cements should give a tensile strain of over eighty-five pounds when immersed in water seven days.

In the Eastern States it costs about 70 cents per barrel to manufacture the best grades of cement. In California, with its higher prices of labor, it should not cost over $1 per barrel.

PORTLAND CEMENT.

Maurice St. Leger, of Camberwell, took out a patent in 1818: "I take chalk or any other substance from which lime can be obtained, which I pulverize, and to which I add common clay or any other substance containing alumina and silex, which I increase or diminish according to the required strength of the lime. I mix them together until they become a paste, which I then make into lumps. These lumps after being thoroughly dried I put into a kiln and expose to the fire in the usual way of making lime. The degree of heat must depend on the size of the lumps, but I find the lumps have been sufficiently burned when they can be broken by the hand."

Instead of chalk, stone, or such other substance as are above mentioned, ordinary lime slacked or pulverized may be substituted. The quantity of clay or other substance containing alumina and silex to be added to the chalk, stone, lime, or other substance, must depend as well upon the quality of the chalk as upon the quality of the clay or other substance containing alumina or silex.

In 1824, James Aspdin, of Leeds, England, took out a patent in the following words:

"My method of making a cement or artificial stone for stuccoing buildings, or any other purpose to which it may be applied (and which I call Portland cement), is as follows: I take a specific quantity of limestone such as that generally used for making or repairing roads.

"I take it from the roads after it is reduced to puddle or powder, but if I cannot procure a sufficient quantity of the above from the roads, I obtain the limestone itself and I cause the puddle or powder or limestone, as the case may be, to be calcined.

"I then take a specific quantity of argillaceous earth or clay and mix them with water to a state approaching impalpability, either by manual labor or by machinery.

"After this proceeding, I put the above mixture into a slip pan for evaporation by fire till the water is entirely expelled. Then I break this mixture into lumps and calcine them in a furnace similar to a lime kiln till the carbonic acid is entirely expelled. The mixture so calcined is to be ground to powder, and is then in a fit state for making cement or artificial stone."

Up to 1840 all the inventors and experimenters were afraid to raise the heat higher in burning than was necessary to expel the carbonic acid.

To Joseph Aspdin, who for over fifteen years had followed the method in vogue in the manufacture of the so called English Roman cement, is due the credit of departing from the established custom of burning at a moderate heat, and thus giving to the world the triumph of technical chemistry, Portland cement.

Portland cement is purely a chemical product, practically a double silicate of alumina and lime. There are three methods used in Europe to reduce the raw material to the required degree of fineness, known as the "wet," "semi-wet," and "dry" processes.

The "wet" method is principally used in England on the Thames and Medway. The chalk is first passed through rock breakers and then ground wet in mills similar to a Chili mill, from which it is passed to the wash mills, where the requisite clays and water are added. The wash mills are large circular tanks with arms or racks revolving in them. Through this agitation the combined materials are thoroughly incorporated, and are about the thickness of cream. From the wash mill it is allowed to flow to the reservoirs. After the slum, or "slurry," has settled the water is drawn off and the residual "slurry" is allowed to evaporate till it becomes a thick mud. From these reservoirs it is carried to the dry floor, where all remaining water is expelled, and it is then broken in pieces the size of a brick. The great disadvantages of this process are, first, the limestone and clay being of different specific gravities are liable to and do separate from each other; second, large areas of land are required for reservoirs; third, the excessive labor in handling and rehandling; fourth, the time elapsing from the first manipulation of the raw material till it is ready for kilning, taking months.

This process was the one made use of before the requisite machinery had been invented, and continues to be used by many of the original works.

A number of them, however, have modified their processes to the "semi-wet" way.

In this method the chalk and clays are passed through the wash mill with as little water as possible, and after being intermixed, are conveyed to millstones, from which it flows to the drying plates, where it is dried and is then ready for the kiln. Even by this process large areas of dry floors are required, as well as labor, time, and fuel.

In the dry method, the dry raw materials are mixed in their correct proportions, passed through rock breakers which feed rolls, and from here the yet coarse powder is conveyed to the millstones, by which it is reduced to such a fineness that 80 per cent will pass through a one hundred-mesh screen. From the stones it is elevated to bins, from which it is carried by double conveyors to pug mills.

During this passage to the pug mill sufficient water is added to make the particles firmly adhere together. From the pug mill it is carried to the dry house, and is ready for the kiln in twenty-four hours.

In place of "pugging," the mixed ingredients have a few per cent of water added and are conveyed directly to a dry brick press, from which it comes ready for the kiln.

The advantages of the "dry process" are, first, the rapidity with which the materials can be combined ready to burn; second, the saving of labor is about two thirds; third, there is a certainty that the different materials have at no time become separated, and that you have an unvarying product; fourth, less ground is required for works.

The original cost of a dry plant is greater than for a wet, which, however, is amply compensated for by the rapidity of production, not having, as in the "wet process," to wait on a half finished product for which labor has been paid.

There are other processes for the reduction of the raw material, only one of which is particularly worthy of notice, "the double kilning."

The hard limestone is first burned to quicklime, then sufficient water is gently sprinkled over it so that it slacks and yet remains a perfectly dry powder; the lime powder is mixed with clay or ground shale and then burned.

BURNING.

The kilns principally used in England are what are known as the "Dome Kilns," which are similar in construction, though slightly differing in shape, to the "American Natural Cement Kiln." Internally they are in the form of an elongated egg, or two frustums of cones, base to base; in height from thirty to sixty feet, and in the widest diameter nine to eighteen feet. One of forty feet high would have about the following dimensions: At the top, eight feet in diameter; from top to seventeen feet down it widens to about twelve feet; for the next fourteen feet (thirty-one feet from top) it contracts to eight feet; from there to the grate bars (thirty-six feet from top) the diameter is six feet. The ash pit or draw hole is about four feet high. The lining throughout is firebrick.

The mode of burning in this kiln is simple. Wood is placed on the grate bars, two feet high; then a layer of coal, on which alternate layers of coke or hard coal and dried lumps are arranged. The proportion of coke to material decreases from bottom upward. About 10 per cent of the weight of the raw material of coke or anthracite coal is requisite to burn such a kiln.

These kilns are intermittent. When once lighted they burn till all the fuel is exhausted. The reason is that the material being burned at such

a high heat, the cement clinkers adhere so strongly to the side that it is impossible to draw it all from the bottom without first loosening it from the sides.

A ring kiln is a circular or oval flue (burning chamber) surrounding a smoke chamber, within which circle is a central stack. The burning flue is so arranged that at certain distances it can be separated into sections by dampers which are let in from the top. These sections are connected by smoke flues (having valvular dampers) with the smoke chamber. Each of the burning sections has a doorway through the outer wall five feet high by four feet wide, through which the kiln is loaded and unloaded. The tops of burning sections are pierced with holes for admission of fuel. These holes are three to four feet apart, in three rows, there being from fifteen to twenty-one in each section.

To explain the method of burning in this kiln: Assume the sections of the burning chamber to be numbered one to fourteen. The dampers between sections one and fourteen closed (down), and the valvular damper of fourteen connecting it with the smoke chamber opened (all the other valves in the smoke flue being closed).

Let section one be loading and two unloading, the air for combustion goes in at the doors of sections one and two and passes successively through sections three, four, five, and six, which have been in heat to seven and eight, the ones in which the fuel is being used, the heated gases pass from seven and eight on around through the sections till they reach fourteen where they enter the flue to smoke chamber.

The air passing in doors one and two as it goes through sections three, four, five, and six takes up heat, cooling the burned material. By the time the air enters seven it has become so heated that it will make a small bar of iron red hot. Sections six and seven were in heat yesterday, five and six the day previous; to-morrow in place of seven and eight being in heat, eight and nine will be, and seven will be cooling; then the dampers between fourteen and one will be opened, and that between one and two closed; the valve in the smoke flue of fourteen will be closed, and that of one open; then section two will be loading, and three unloading.

The materials in sections nine and ten, the ones beyond those in which the fuel is being used, are in such a state of heat that the carbonic acid is nearly all expelled and ready to clinker, the next two are getting hot, the last two, thirteen and fourteen, are drying.

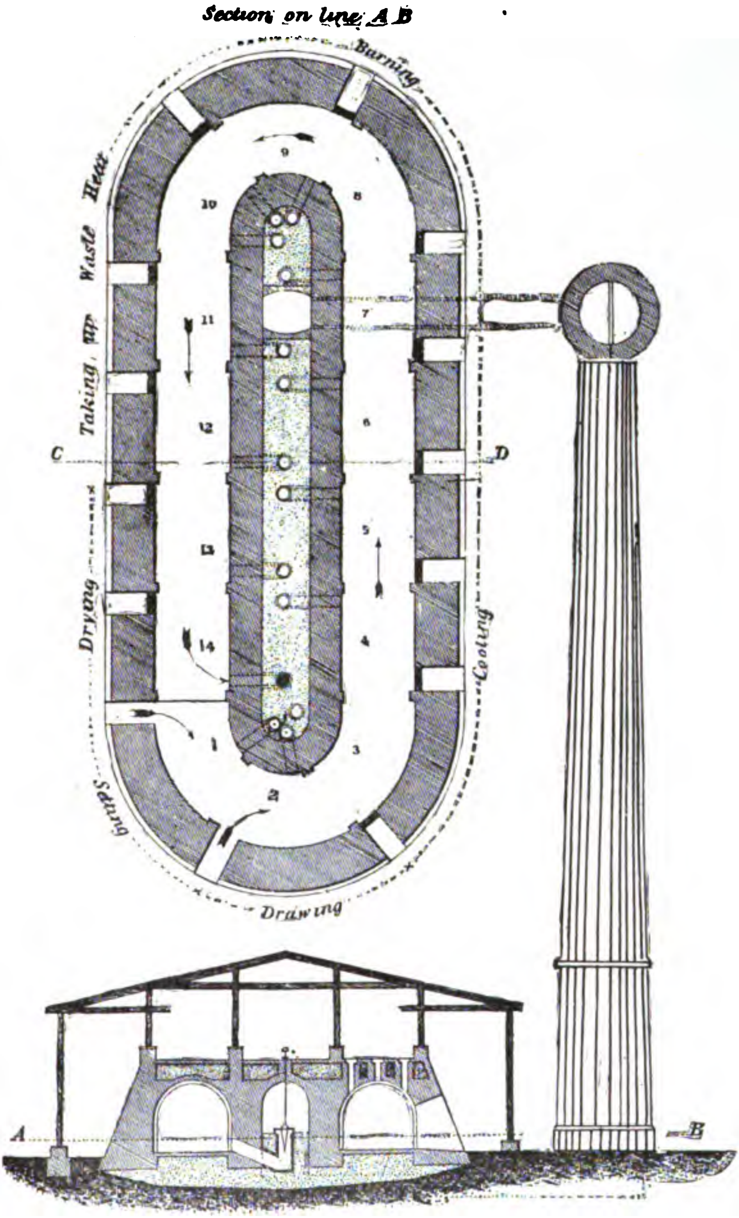
The heated gases from the sections on fire give up their heat in passing through the unburned sections, so that when they enter the smoke chamber they are cooled below 160 degrees Fahrenheit. The material to be burned is arranged in the sections something similar to a brick kiln. As will be seen in the sketch there are fourteen sections, one being burned each day, requiring fourteen days to complete the circuit. Kilns on this plan can be made much smaller, having less and smaller sections.

There are other modes of burning, but the great cost of kiln precludes their general use.

Cements have also been burned with wood and coke and there is no reason why wood alone could not be used.

Crude petroleum oils can also be used to burn cement and are being used for that purpose (I am told) in Pennsylvania. This fuel could not be applied successfully to the dome kiln, but could be applied to a Hoffmann or ring kiln, such a method being particularly applicable to the southern part of the State.

The question should be well considered: What fuel or combination of fuels would be the cheapest to use, as the prices of those articles are con-



HOFFMAN'S ANNULAR KILN.

stantly varying, so that the manufacturer should not be at the mercy of syndicates. To place the manufacturer beyond the reach of such trusts, it would be advantageous at the commencement of work to construct a ring kiln, or something similar, so arranged that crude oil and coal could be used in combination, or either of them separately.

CLINKER.

Artificial cement, when correctly proportioned and burned, is a dark bronze-green mass, resembling lava in texture; such heat should be used that, after all the carbonic acid is expelled, the mass contracts, clinkers, changing its color from yellow to bronze-green; such clinker dusts but slightly when taken warm (not hot) from the kiln when exposed to the air; this dusting is due to the over-burned edges having cindered.

A clinker of brown color, which when taken from the kiln dusts excessively, producing a soft, smooth feeling powder, is dangerous; it contains an excess of clay, and is weak in indurating capacity; such cement will contract after being used. Much less fuel is required to burn such an abnormal combination.

A clinker of black color, which does not dust when taken warm (not hot) from the kiln, and, when powdered, has a bluish cast, contains an excess of lime, which is dangerous. If the excess of lime is not great it can be purged of its dangerous quality by spreading it out on floors till the excess of free lime has become neutralized by the action of the air. It can then be used without danger; but if the excess of lime is very great, no exposure will eradicate its dangerous quality. To show an instance of an excessive over-limed cement: The cement was spread on a floor three inches thick for four months, till a small ball, remaining in the water seven days, showed no crack; then the cement was made into a slab and kept damp; at the end of two months the slab was examined and found full of surface cracks; in prying down with a knife in these cracks, small pellets would fly; in a month or two more, after exposure to dry air, the whole face began to crumble. To manufacture such a cement is expensive, it takes large amounts of fuel to clinker it, and time is lost by the long exposure required to annul its dangerous quality.

If there has to be an excess of lime or clay, it would be better for the manufacturer to have a *slight* excess of lime rather than an excess of clay.

The powder of a normal or perfectly combined clinker, should, when freshly ground, be of a gray color, tinged with green, which, after exposure for a few days, should lose much of its green cast, and should be granular in character when finely ground, and should at no time have a smooth or silky feel.

COMBINATION OF MATERIAL.

Artificial or Portland cement can be made from a combination of any limestones (which make quick lime) with clays (or any materials that form clays), and which under heat will react chemically on each other. It is necessary that the materials be of such a nature that they can be reduced to a minimum state of division, so that 80 per cent shall pass through a one hundred-mesh screen; that the silica, alumina, and iron in the clay or rock shall be in chemical combination, and that there shall be little or no silica in the form of sand; if there is any, it must be naturally in a minute state (all passing a one hundred and twenty screen) and not exceed 1 per cent.

Many of the imported cements contain an excess of sulphate of lime, derived either from a contamination of the limestone with gypsum, or the result of the oxidation of the sulphurets that existed in the clay or shales, or due to the sulphur that is always present in a greater or lesser degree in the fuel. This sulphate of lime (plaster of Paris) is detrimental to a cement, and should not be tolerated in appreciable amounts. But in com-

puting a combination for cement an allowance of lime should be made for the sulphur, to be computed into sulphate of lime.

It is necessary that the powdered raw material should be thoroughly intermixed.

In England the principal portion of the cements are made from chalk and river mud; but in those sections distant from the chalk, the hardest mountain limestone is combined with the hardest shales.

The same varieties of material are used in France as in England, but in Germany the dry method is much more used. Since the advent of the dry process, the fallacy that cement could be made only from the softest materials has been disproved, as now in England and Germany cements of the highest grade are made by the dry process from the most obdurate materials.

Analyses of Some Limestones from which Portland Cement is Made in England.

	Chalk.	Chalk.	Chalk.
Silica, clay, and sand	2.04	.66	.83
Carbonic acid	42.14	42.98	43.51
Sulphuric acid	.31	-------	-------
Phosphoric acid	.07	.08	-------
Lime	54.37	55.24	55.21
Magnesia	.25	.10	.11
Potash	.08	.06	-------
Soda	.19	.14	-------
Alumina Iron	.55	.74	.34
Totals	100.00	99.93	100.00

Analyses of Clays and Shale Used in England.

	Clay.	Clay.	Shale.
Silica	68.45	70.56	64.11
Alumina	11.64	14.52	20.77
Iron	14.80	3.00	8.43
Lime	.75	4.43	1.01
Magnesia	-------	-------	.63
Soda	2.90	3.95	1.24
Potash	1.10		1.84
Carbonic acid	-------	3.45	-------
Totals	99.64	99.91	98.03

Analysis of Some of the Hard-clay Limestones from which Cements are Made in the United States.*

Silica	12.80	13.72	14.68
Alumina	4.25	4.00	5.32
Iron	1.09	1.04	1.12
Lime	40.80	40.06	38.78
Carbonic acid	35.33	33.76	32.40
Magnesia	2.23	2.08	1.75
Sulphate of lime	1.60	1.79	2.29
Phosphoric acid	.10	.09	.09
Organic matter	1.57	1.78	1.68
Totals	99.77	98.32	98.11

* Taken from the geological report of Pennsylvania.

Near Kingston, New York, the material from which Portland cements are made is a hard limestone, combined with two varieties of clay (Fuller's earth and pipe clay).

ANALYSES OF SOME WELL KNOWN FOREIGN CEMENTS.

	1.	2.	3.	4.	5.	6.
Lime	59.06	62.81	61.64	55.28	56.68	58.03
Silica	24.07	23.22	23.00	22.86	22.74	21.11
Alumina	6.92	5.27	6.17	9.03	7.74	11.30
Oxide of iron	3.41	2.00	2.13	6.14	3.70	3.36
Magnesia	.82	1.14	....	1.64	0.57	2.98
Alkalies	1.60	1.27	....	.77	.63	.71
Sand	1.47	2.54	1.28	1.08	.53	.49
Sulphate of lime	2.85	1.30	1.58	3.20	1.66	.51
Carbonic acid	....	....	....	....	3.50	.83
Water	....	....	....	....	1.90	.54

One to five are from Wagner's Technology; five and six are from Reid.

All the above cements are products from a few of the manufacturers whose output is noted for great tensile strength.

As will be seen the relation between the clay and lime elements differ considerably. To account for this difference a series of tests were made at the Mining Bureau.

The clays were combined to obtain the following percentages:

	1B.	2B.	3B.
Silica	63.10	62.33	60.72
Alumina	27.69	25.11	19.64
Iron peroxide	9.21	12.56	19.64

To these compositions carbonate of lime containing carbonate of magnesia and alkali were added in correct proportion; the resulting cements gave the following analyses:

	1Ba.	2Ba.	3Ba.
Lime	60.58	60.30	59.72
Magnesia	1.22	1.28	1.25
Alkalies	1.24	1.22	1.28
Silica	23.22	23.13	22.90
Alumina	10.19	9.32	7.43
Iron	3.39	4.66	7.40
Totals	99.84	99.91	99.98

The relation of clay to lime elements in the above is as follows:

1Ba	100 clay to 171 lime.
2Ba	100 clay to 169 lime.
3Ba	100 clay to 165 lime.

Taking analyses 1 and 6 foreign cements mentioned above, and recomputing, throwing all extraneous matter aside, we will have—

	1A.	6A.
Lime	61.59	59.55
Magnesia	0.85	3.00
Alkalies	1.65	0.75
Silica	25.14	21.66
Alumina	7.22	11.59
Iron	3.55	3.45
Totals	100.00	100.00

The relation of clays to lime elements in the above proves that lime and clay elements may vary to a considerable extent, as was shown before.

1A.	100 clay to 178 lime.
6A.	100 clay to 172 lime.

Hence, by comparison, we can conclude that where there is an excess of silica in combination in the clay the relation of clay to lime elements would be about 10 clay to 18 lime, but when the iron predominates in the clay the relation may be 10 clay to 16½ lime. What is to be understood is that the lime, magnesia, and alkalies, taken together, are the lime elements, and that the lime should be not less than 95 per cent of these elements.

Then any cements which contain less than 60, or over 66, per cent of of lime elements are faulty. All cements which contain over 2½ per cent of alkalies are bad, as the alkaline silicates decompose; the alkalies forming salts, which show as efflorescences on the exposed surfaces.

CEMENT TESTING.

Much of the cement which comes to this coast is faulty, in not having the requisite tensile strength. The government standard is that "briquettes" of neat cement of one square inch area should stand a tensile strain of two hundred and fifty pounds in seven days. The method of making the "briquette" is as follows: The gauged sample of cement to be tested is placed on a non-absorbent surface, and 20 to 25 per cent of its weight of water added, then mixed quickly and thoroughly, and firmly pressed in the mold (not tamped). When the "briquette" has set, which generally takes from thirty to fifty minutes, according to the nature of the cement, the mold is removed and the briquette kept in a damp place (the temperature to be about 60 degrees Fahrenheit) for twenty-four hours, and then immersed in water six days before breaking. Some testers prefer to place the briquette in water as soon as possible after the mold is removed.

Further tests should be made on cement to ascertain its setting quality and if it contains any free lime, for which two small "pats" are made about two inches in diameter, the edges drawn down thin. One is placed in water, and after its immersion thirty-six hours, if no cracks around the edges appear, it may be considered safe. The other is left in air, and should remain a dark gray color. If it is yellow the cement contains too much clay.

A cement as shipped by the manufacturer stood a tensile strain at the end of seven days of two hundred and ninety-one pounds; when combined with an equal weight of sand it withstood a strain of one hundred and fifty-nine pounds. The same cement when reground passing through an eighty-mesh screen, after seven days, stood a strain of two hundred and

sixty-six pounds, and with an equal weight of sand added, it stood a strain of one hundred and eighty-eight pounds.

In cements which are not finely ground, the coarse particles of unground cement clinker, act the part of sand; hence, when the same quality of cement is finely ground, the capacity of the cement to take sand is increased, though it will not give as high a tensile strain as when tested neat.

The tests of cement should be of comparison made under like conditions of fineness, sand, and temperature. Only those portions of cement should be used that pass a seventy-mesh screen. The sand should be washed clean from all clay particles and of such a size that all should pass through a twenty-mesh screen and be retained on a thirty-mesh; the sand should have angular edges. When testing the tensile strain, the weight should be so applied that it continually increases, and should not be faster than four hundred and fifty pounds per minute.

By this method of testing it will be found that many cements that show the highest tensile strength neat, do not (as one would naturally infer) maintain their reputation (as it were) when mixed with sand and compared with others under like conditions.

The three cements made at the Bureau, previously spoken of, were all passed through a sixty-mesh screen and tested neat, showing a tensile strain as follows:

	Days.	14 Days.	28 Days.
Number 1	325	365	436
Number 2	314	368	441
Number 3	286	339	421

Number one set much more rapidly than two or three, at seven days. Numbers two and three have not attained the hardness of number one, yet their ratio of increase was much greater, and in twenty-eight days number two has surpassed number one in strain. To determine the cause of the anomaly more exhaustive tests would be necessary.

In the foreign cements, five and six, referred to on page 876, number five contains a large excess of silica in its clay, and number six an excess of alumina. In the first week number five stood the highest strain, but in twenty-one days it was surpassed by number six. It may generally be concluded that when the alumina or iron elements are large in the clay, the cement will be slower in setting than one where the silica in the clay predominates. The two cements, five and six, were competitive, both being nearly theoretically correct as to composition.

To show the relative value of natural and artificial cements: Let three stones of same composition, their elements being in correct proportions; the first two burned as natural cements; the third before burning being pulverized and made into pats with water and dried. In burning the first, only sufficient heat is used to expel the carbonic acid, in the second sufficient heat to slag the edges after the carbonic acid has been driven off. The third with sufficient heat to clinker. It will be found the first gives a light, soft powder, weighing about eighty pounds per struck bushel. The powder of the second is more dense and granular, yet the major portion of which has a smooth feel and will weigh from ninety to one hundred pounds per bushel. The third will give a distinctive granular powder, weighing from one hundred and fifteen to one hundred and twenty-five pounds per bushel.

The first cement will be quick setting, soon attaining its maximum hardness and strength of eighty pounds per square inch in seven days; the initial set of the second will be much slower than the first, yet will attain a tensile strength of one hundred and sixty pounds in seven days; the third, Portland cement, will withstand a strain of two hundred and fifty pounds and upwards in seven days, and will continue to harden long after the first and second have reached their ultimate strength.

The relative value of such cements, made from the same material, will be about as follows: one part of the third cement, combined with three parts of sand, would be equal to four parts of the first used neat.

Many engineers and architects have conceived the idea that cements, when correctly burned, giving the highest tensile strain in short periods of time in comparative tests, are the best. Such results can be attained with cements that are over-limed and aerated, as well as in those in which the lime is present in correct proportions, and as well as in others in which the silica is in excess. Such cements will increase in hardness for sixty to ninety days, but after that the improvement will be slow; after they have attained an ultimate strength at the end of about a year and a half, they will begin to retrograde. In those cements manufactured from material in which the silica of the clay is in perfect chemical combination with alumina and iron, and such true clay combinations are correctly combined with the lime elements, it will be found (when correctly burned) that these cements attain their initial set much more slowly than those before spoken of, but will continue increasing in strength long after the others have ceased to show any marked increase, and will, after the one and a half years before mentioned, continue to improve when the others are retrograding.

Nature crystallizes slowly. In the production of cement, man must copy nature's methods to obtain perfection.

The nature of the raw material from which cement is to be made, would in a great measure control the class of machinery necessary to reduce them. By the dry process, a mill to reduce obdurate materials would require something similar to the following plants, which would manipulate forty tons of raw material, making twenty tons or one hundred barrels of cement:

Machinery for raw department would consist of two revolving dry kilns, two rock breakers, two sets of rolls, and three sets of stones, with the requisite conveyers and elevators with two pug mills or a dry press brick machine. The clinker or cement grinding portion would be similar to that described under natural cement. About two hundred-horse power would be necessary to drive such machinery.

The question where works should be situated is of all questions the one of most vital import. They should be close to short transportation, preferably on tide water, so that fuel and cement can be transported by vessels.

The raw material should be quarried, not mined, nor costing over sixty cents per ton. The quarries should be close to the works so that broken rock will receive but one handling.

Barrels are another great expense which, in local trade, could be nearly dispensed with, as is done in Europe, where sacks are used marked with their distinctive trade mark. When sacks are returned in good order, rebate for same is allowed, which makes the cement cheaper to consumers as well as effecting a saving to the manufacturer in repairing old barrels.

In the portion of California bordering the ocean, the mass of limestones are more or less impregnated with clays and magnesia; in some sections they are as soft as chalk, but none attain the hardness of mountain limestone. In every section where limestones are found on this coast, it may be

noted that clay or shales are also found in close proximity. Some of the limestones in the southern part of the State are charged with sulphate of lime to such an excess that they could not be used. But the major number of deposits are free from this injurious ingredient, particularly so the soft shell limes.

The old Spanish padres were well acquainted with the character of this limestone, making use of it in all their hydraulic works where strength and durability were required. At the Mission of San Fernando, they used lime made from shell limestone in constructing a dam for a reservoir one hundred feet long, twenty feet high, and twelve feet thick at the base.

Their method was similar to that adopted by the old Romans; the mortar, after being made, was mixed with broken stone, and gently tamped until each layer (eight inches) was firm and solid. The same shell lime is exposed at San Fernando, and crops out on the mesa at various places, going towards Orange, at the Los Alisos ranch, seventeen miles south; going towards San Juan by the Sea, there is a large exposure by a cañon cutting through the mesa.

ANALYSES OF SHELL LIME.

Carbonate of lime	81.36	65.26
Carbonate of magnesia	.76	1.22
Silica, Alumina, Iron	14.25	27.08
Sulphate of lime	.42	1.02
Alkalies	1.32	2.02
Water	1.25	1.20
Totals	99.36	97.80

(In the analyses made at the Bureau the specimens were much weather worn and decomposed, and were inferior to the same material when freshly quarried.)

The deposit at Los Alisos ranch is about an equal distance from Los Angeles and San Diego, and is well situated for a local manufactory. Undoubtedly the same class of deposits can be found on the coast. Along the coast, through Ventura, Santa Barbara, and San Luis Obispo, the same class of soft limestones, as well as those of a hard nature, are found.

In proximity to the town of Santa Cruz are extensive deposits of soft, concretionary limestone, resembling chalk in character. This material as a cement ingredient cannot be surpassed. It can be reduced to the minutest state of division at a minimum cost; and through its fine, soft texture when pulverized mixes readily and intimately with the finely pulverized clay or shale, which are found in large beds and deposits in close proximity to the limestones. These clays and shales are of fine texture, and contain no injurious elements.

Analyses of Santa Cruz Lime, Clay, and Shale.

	1.	2.	3.	4.	5.
	Limestone.	Limestone.	Clay.	Clay.	Shale.
Lime	51.31	50.02	2.83	3.37	1.96
Carbonic acid	40.32	39.25	Trace	Trace	Trace.
Magnesia	1.25	.75	Trace	.25	Trace.
Alkalies	1.45	1.80	.21	1.36	.81
Silica	2.40	4.71	63.73	60.03	62.22
Alumina	.51	1.20	22.12	21.76	20.02
Iron	.56	.60	9.01	11.49	8.25
Water and carbonaceous matter	1.21	1.40	1.12	1.45	6.52
Sand					.25
Totals	99.01	99.73	99.02	99.71	100.03

From the above materials cements have been made of a superior quality, and having the following composition:

	1.	2.	3.
Lime	61.91	61.26	60.53
Silica	23.48	24.12	24.38
Alumina	8.47	7.22	8.64
Iron	3.69	5.18	3.82
Magnesia	.88		.91
Alkalies	1.23	1.51	1.15
Sulphate of lime	.10		.32
Sand and clay	.20		.11
Totals	99.96	99.29	99.86

Number one weighed 107 lbs. to the cubic foot; number two 105½, and number three 104¾. The tensile strains were:

No. 1	452 pounds in 7 days.
No. 2	410 pounds in 7 days.
No. 3	396 pounds in 7 days.

In the Counties of San Mateo and Santa Clara there are many exposures of limestones which are harder than those of Santa Cruz County, but as a cement material they are good, having within themselves all requisite ingredients.

Large quantities of argillaceous limestones are found between Niles and Mission San José. Cement has been made from these stones which is of a superior quality.

From Wm. Jones, Esq., I have obtained the following analysis and information:

Carbonate of lime	48.9
Carbonate of magnesia	27.7
Iron and alumina	4.1
Clay and silica	19.1
Total	99.8

"From this limestone with the addition of 20 per cent of carbonate or lime a Portland cement has been made showing by briquettes breaking twenty-eight days from time of gauging neat, a tensile strength of one thou-

sand and forty pounds to the square inch. This largely exceeds the strength of English Portland, the strength required by English and German engineers being five hundred pounds to the square inch in twenty-eight days from gauging."

Two miles back of Berkeley, in Alameda County, there is a stratum of soft clayey limestone which would make a good cement upon the addition of lime.

In the neighborhood of the waters connected with the Bay of San Francisco, stones of varying composition are attainable, from those containing 95 per cent of carbonate of lime down. In Solano County, the limestones in beds and deposits are exposed from Vallejo to Goodyears. The following is the analysis of a limestone found near the town of Benicia:

Carbonic acid	41.96
Lime	50.85
Clay	6.12
Magnesia	.24
Alkalies	.83
Total	100.00

Contra Costa has from Mount Diablo to Pinole the same class of material as those found in Solano County; the following is the composition of some of them:

	1.	2.	3.
Lime	33.35	17.98	40.32
Magnesia	1.25	2.60	2.26
Silica	9.05	42.61	12.89
Alumina	7.56	15.05	-------
Iron	5.20	4.10	2.95
Manganese	-------	.70	.15
Alkalies	2.05	.26	.37
Carbonic acid	28.56	14.12	40.11
Sulphuric acid	1.03	.84	-------
Water	2.05	.96	.67
Totals	100.10	99.22	99.72

No. 1 analysis made at Bureau.
No. 2 analysis made at Bureau.
No. 3 analysis made by Weber.

A good Portland cement has been made at Benicia from a combination of materials from Contra Costa and Solano Counties.

The clayey limestone came from Benicia and the purer stone from the neighborhood of Martinez. It was not necessary to go so far for material, as beds of the same character were in close proximity to the works.

The cement had a chocolate cast of color, due to the presence of manganese. One hundred barrels were made, and the product stood a tensile strain of four hundred and forty pounds in twenty-eight days. The results obtained, considering that the necessary preliminary tests had not been made, were highly satisfactory.

For a further description, where suitable lime is found, see report on San Luis Obispo, San Mateo, Santa Cruz, Monterey, Santa Clara, Santa Barbara, and San Bernardino Counties.

To conclude this portion of the article: It is evident from the following that cements can be made from California materials superior to most of those imported, because the silica, alumina, and iron in the materials used

are in more correct proportions. The California cements are slow in their first initial set, but continue to improve long after the others cease to show marked increase, as will be seen by the three following reports of tensile strains in pounds per square inch area.

From annual report of the operations of the Engineer's Department of the District of Columbia, by Major G. J. Lydecker, U. S. A.:

FOREIGN CEMENT.

Name.	1 Day	5 Days	10 Days	15 Days	20 Days	30 Days	60 Days	90 Days	6 Months	12 Months
Byckerhoff	170	335	353	362	380	430	525	570	670	700
J. B. White & Bros.	175	340	355	369	390	442	535	600	690	728
O. F. Olson & Son.	165	320	360	370	379	440	545	610	680	700
Breecks, Shoobridge & Co.	143	319	340	352	370	426	530	592	635	695

AMERICAN CEMENT.

Name.	1 Day	5 Days	10 Days	15 Days	20 Days	30 Days	60 Days	90 Days	6 Months	12 Months
Sailor	125	246	310	340	360	390	400	425	495	657
Standard American	120	313	371	472	490	590	......	......	......	......

In the following table numbers two and three California were tested by prominent engineers on this coast, to compare them with those imported, and in each instance the California has shown itself superior in every respect.

CALIFORNIA CEMENTS.

Name.	3 Days	7 Days	14 Days	21 Days	28 Days	84 Days	103 Days
1.	......	255	......	......	440	......	......
2.	......	......	......	......	1,040	......	......
3.	137	359	562	609	665	715	784

General Gilmore states "that the cost to manufacture cement in Germany, all contingent expenses included, is from $5 80 to $5 90 per ton, and is sold at a net profit of 30 to 40 per cent on the outlay." One ton of cement equals five barrels.

The cost of a plant to produce one hundred barrels (twenty tons) per day, in California, would be about $60,000; and the cost of manufacturing should not exceed $1 80 per barrel, or $9 per ton, which, if sold at $2 50 per barrel, would leave a handsome profit to the producers, as well as retain the money at home which is now helping to enrich foreign countries.

As was stated in the first portion of the article from data obtainable there was imported from Europe last year (1887) three hundred and

thirty thousand eight hundred and fifty-three barrels, which was invoiced at $305,983, or a value of ninety-two and one half cents per barrel, which is about the price it costs to manufacture the cement in Europe. In addition to the invoiced price there is the cost of barrels and manufacturer's profit. The duty on cement is 20 per cent ad valorem, the barrels not paying duty.

There was imported into the United States from Europe one million seventy-nine thousand nine hundred and forty-four barrels of cement, invoiced at $1,108,819, during the fiscal year ending June 30, 1887, of which amount San Francisco received two hundred and eleven thousand five hundred and thirty-three barrels, invoiced at $214,705, or nearly 20 per cent of the whole amount.

About as cheap as the best grade of foreign cement can be laid down in San Francisco, when freights are low, is $2 60 per barrel; hence, any parties going in the business would at once place themselves beyond foreign competition, if sufficient forethought were used in selecting the proper materials; works being so situated that the manufactured article could be transported to various markets at nominal cost.

BUILDING STONES.

Wm. Irelan, Jr., *State Mineralogist:*

Dear Sir: In sending you the following results of the examination of a few California building stones, I take this occasion to express the great regret we both feel that so little response has been made to the circular sent out over a year ago from the State Mining Bureau by those interested in the development of our building stone resources. In that circular, the owners of building stones were invited to send carefully selected samples to the Bureau, in order that a careful investigation of their mineralogical, chemical, and physical properties might be made and published in the annual reports of the Bureau. The advantages to the quarry owner of such an examination and publication of his stone are so obvious that it is difficult to understand why so few have availed themselves of the invitation. With the results of such an investigation in hand, the expense of opening unfit material might be saved; capital could be more easily commanded for opening a quarry of stone of proved value; other things being equal, in competition a stone that has been tested would be given preference over one that had not been tested; and in competition with eastern building stones, many of which have been carefully tested, the proposed examination furnishes a desirable basis for intelligent comparison. In spite of these obvious advantages, in fifteen months but six building stones have been forwarded by their owners for examination. Numerous other stones are in constant use, and in response to the rapidly growing demand for stone to replace the iron that has for so many years offended the eyes of lovers of good architecture, new quarries are being rapidly opened whereever transportation facilities enable the stone to reach a profitable market.

The failure to send these stones can only mean that the material is already so well established in popular esteem as to enable its owner to feel indifferent to the above cited advantages, or else that a fear exists that an examination will discover, and make public, qualities of inferiority or of fatal defect. A proper public spirit should induce the owners of the former class of stones to submit their material for examination; all good citizens are interested in having the genuine resources of our State as well known and as widely appreciated as possible. To get at the latter class of stones will certainly be more difficult. The writer has been compelled to condemn as unfit for building material many stones privately submitted to him. Doubtless other unfit stones are in actual use. The difficulty, the impossibility even, of recognizing unfitness without such an investigation as few are able to make, renders it easy for inferior and worthless stones to secure recognition if they happen to commend themselves to an architect by a desirable color or to a contractor by cheapness and facility of working.

Years may elapse before unfitness is rendered evident by actual experience in building, and in the meantime large sums have been expended, costly and beautiful buildings have been erected—buildings in which all the skill, taste, and genius of an architect have been embodied—condemned to early and inevitable decay by some fatal defect in the stone that was used. Untold millions have been ignorantly wasted on mining enterprises

on this coast. Now that the stone-building era has fairly dawned upon us, let us not repeat this experience in another field.

It is true we might purchase specimens of stones in the market that can be obtained in no other way, but for two reasons this course is undesirable: First, the danger of not obtaining authentic material; and, second, of not obtaining fairly representative material. The quarry is the only proper place for selecting the specimens to be tested, and so long as the expense of sending an expert directly to the quarries cannot be defrayed, we must be content with the selection made by the quarry owner himself. The danger of obtaining unauthentic material by purchase is, I fear, illustrated by present experience. Five of the seven building stones reported upon in this paper were purchased in San Francisco by a representative of the Mining Bureau, and two of them I suspect to be the same stone under two different names.

We had hoped by this time to have examined most of the building stones in use on this coast, for publication in your annual reports; we have published the results of the examination of only twelve. The work will be continued as the material becomes available, and in the end the results may be gathered together in compendious form for the benefit of the architects and builders of the coast.

The present paper contains the results of the examination of the Angel Island sandstone, the Sespe brownstone, of Ventura County, sent by the Los Angeles Granite and Brownstone Company, of which Mr. C. M. Lawrence is President, and of the following five stones, which were purchased by a representative of the Mining Bureau at some stone yard in San Francisco, and sent to me in Berkeley: Altamont sandstone, from Alameda County; San José sandstone, from Santa Clara County; Penryn and Rocklin granites, from Placer County; and Mount Raymond granite, from Fresno County.

ANGEL ISLAND SANDSTONE.

Macroscopic.—This is a markedly bluish-gray, fine-grained stone, showing upon close examination granules of grayish-white quartz and feldspar, distinguished respectively by their conchoidal fracture and smooth cleavage surfaces, black mica scales, and angular fragments of black clay slate, varying in size from 15 mm. or more in diameter, to minute black particles that are thickly disseminated through the stone. These granules and fragments are held in a dull, earthy, scarcely perceptible cement, hardened somewhat by carbonate of lime. A drop of acid will produce a slight effervescence anywhere upon the surface of the stone. The stone, in hand specimens, is free from flaws, is rather soft, and will work very freely under the hammer. The direction of the grain is sufficiently well marked by the mica scales to enable one to tell the edge from the bedding surface. A failure to make note of this, and to follow the simple rule in stone construction, to place the stone blocks with lamination horizontal, has caused no little trouble in the use of the stone in at least one notable instance.

Microscopic.—Somewhat less than half the granules are quartz. They are very irregular, sharply angular in shape, in the main clear and colorless. Exceptionally large granules one and two millimeters in diameter occur, but the average diameter is about 0.125 mm. Very small liquid inclusions without and with, both movable and fixed, bubbles are plentifully distributed in bands and irregularly through the quartz granules. The feldspar fragments are rather more plentiful than the quartz. They also are angular and from about 0.5 mm. in diameter to minute grains. Both potash and soda-lime feldspars are present from comparatively fresh to

totally decomposed and kaolinized granules. The thin biotite scales are closely and irregularly wedged in among the other granules, and are often partially or completely converted into chlorite.

In addition to these *mineral* fragments thus far noted, an appreciable proportion of the sandstone is made up of small *rock* fragments, of which a black clay slate furnishes by far the greatest portion. They vary in size from the large pieces (15 mm. in diameter), easily seen by the unaided eye in hand specimens, to very minute particles. When cut across the direction of cleavage by the thin section in which the examination under the microscope is made, these slaty fragments present a network of opaque, black, bituminous matter, inclosing minute granules or groups of granules of quartz. A tiny veinlet of granular quartz sometimes runs clear across the fragment. That the black particles are bituminous is proved by their turning white on ignition, at a comparatively low temperature. Less numerous than these slate fragments are small more or less rounded fragments of a very fine-grained, massive rock, basaltic in character. Lath-like, porphyritically disseminated plagioclase and magnetite crystals lie in a matrix rendered nearly opaque by decomposition.

The *cement* is very sparse and consists of fine particles of all of the above mentioned constituents and their decomposition products slightly impregnated with carbonate of lime; its prevailing character is, however, decidedly argillaceous.

The specific gravity of the stone is 2.73, whence the weight of one cubic foot equals 170.6 pounds.

The amount of moisture absorbed in seven weeks equals 1.33 per cent of the weight of the stone, and the absorption of water equals 1.91 per cent. The loss on exposure to carbonic acid gas solution is 0.156 per cent. Exposed to the fumes of strong acid the stone lost its bluish tint and turned to a light gray, discolored by streaks and patches of yellow oxide of iron. The loss of weight during this exposure amounted to 2.13 per cent, and the additional loss on brushing with a stiff brush was only 0.02 per cent. Heated carefully in a muffle furnace to a bright red heat the stone fused slightly in contact with the floor of the muffle; on cooling to just below a red heat the cube was found cracked completely through in several directions, and on then being plunged into cold water the stone became quite friable and fell into several fragments on handling.

The crushing strength determined on cubes 1.456 in. x 1.535 in. x 1.471 in. (ht.) for *bed*, and 1.477 in. x 1.439 in. x 1.489 in. (ht.) for *edge*, resulted in 4,474 pounds per square inch for *bed*, and 4,574 pounds per square inch for *edge*.

The samples were forwarded to me from the Mining Bureau with no statement as to the sender or the buildings in which the stone has been used. The only instance of its use known to the writer is the beautiful building of the Bank of California, on the corner of California and Sansome Streets, in San Francisco. This building was constructed in 1864. During these years of exposure the climate of San Francisco has been very hard on the stone, dissolving out the soft slate fragments so that many surfaces had become quite porous, fissuring off exposed angles in all directions. The decay had finally gone so far that the attempt has been made during the past year to arrest the rapid disintegration by giving the whole exterior surface of the building a coat of paraffine. The success of the experiment remains to be seen. In the meantime the discriminating architect will hesitate to employ in the future a stone that needs to be reinforced with paraffine to save it from the ravages of our exceedingly mild climate.

SESPE BROWNSTONE.

Macroscopic.—A handsome dark grayish-brown sandstone of medium fine-grained texture. Among the specimens examined many were of homogeneous color and grain throughout, while others showed a distinct narrow to broad-banded or laminated structure, the division between the layers being marked by a deeper brown color, and at times a change of texture from coarser to finer grained. In most cases these bands evidently mark planes of sedimentation, but some may be due to a local concentration of the brown oxide of iron in fissure joints of the sandstone; in either case, however, the stone is perfectly firm and shows no marked tendency to break parallel to the bands. A smoothly dressed or polished surface brings out the bands very distinctly, while on a rough surface they are far less noticeable. The unaided eye can easily distinguish dark, smoky gray quartz granules, whitish feldspars, and an occasional white mica scale, held firmly together by a dark-brown cement. The very free effervescence with acid shows that carbonate of lime enters largely into the cementing material. The stone is firm and hard, not friable, and, while working freely under the hammer, it is much tougher than the foregoing sandstone. A weathered surface shows the quartz and feldspar granules standing out in slight relief, but still held firmly in place; the color has changed slightly to a lighter shade.

Microscopic.—No constituents other than those mentioned above are discovered by the microscope. The granules are sub-angular in form, from a quarter to half a millimeter in diameter, and made up about equally of quartz and feldspar. The quartz granules are sometimes comparatively free from, and sometimes completely filled with, minute liquid cavities, with or without moving bubbles. The feldspars are both orthoclastic and plagioclastic, in what proportion it is difficult to say, as both often are decomposed to such an extent as to mask their behavior between crossed nicols. The fresh plagioclases show many kinds of polysynthetic structure; the individuals entering into the aggregates are either broad and straight, wedge-shaped, or exceedingly narrow and wavy, and not a few granules show the rectangular double twinning of microcline. The decomposed feldspars are sometimes opaque from their decomposition products, sometimes converted into a mass showing aggregate polarization, often strongly impregnated with brown or red oxide of iron, giving the brownish-red color to some of the grains seen in the hand specimens. The mica scales, mostly white, although biotite is not absent, are quite isolated, and, like the feldspar grains, are often impregnated with the iron oxide.

The *cement* is variable both in quantity and quality; usually the grains of the stone are almost in contact, with but a slight film of brownish-red oxide of iron between them and filling up the interstices. In places, however, granular carbonate of lime forms a continuous cement, in which the quartz and feldspar granules are thickly disseminated, each grain completely isolated or touching slightly at the angles.

The specific gravity of the stone is 2.65, whence the weight of one cubic foot is 165.6 pounds. The absorption of moisture is 0.76 per cent; absorption of water equals 1.53 per cent; loss in carbonic acid gas solution, 0.24 per cent. Exposure to strong acid fumes changed the shade to a lighter tone, corroded the stone somewhat, leaving it slightly crumbly on the surface, resulting in a loss by disintegration of 2.37 per cent, 2.05 per cent of which was lost quietly in the exposure chamber. This test works unfairly against this stone, as compared with one containing no visible carbonate of lime in the cement, such as, for instance, the Angel Island sandstone,

because while fairly indicating relative tendencies to *chemical* disintegration, it gives no measure of the *mechanical* disintegration to which the loosely aggregated argillaceous sandstones of the Coast Range are particularly liable. On account of its firmness this brownstone would unquestionably resist the combined agencies of chemical and mechanical disintegration indefinitely longer than the Angel Island and similar sandstones. In the muffle furnace the brownstone changed its color at full red heat to a light brownish-red, and developed one crack clear through the cube parallel to the bedding. The rest of the cube was entirely unaffected, neither cracking, scaling, nor becoming crumbly on the surface. Immersion in cold water while still hot failed to affect the stone in the least.

The crushing strength determined on a bed-cube 1.507 in. x 1.534 in. x 1.435 in. (ht.) equaled 4,122 pounds per square inch, and on an edge-cube 1.472 in. x 1.618 in. x 1.595 in. (ht.) yielded 3,892 pounds per square inch.

Occurrence.—The quarries from which this stone is taken are located near Sespe, in Ventura County, California, fifty-four miles from Los Angeles and three and one half miles from the Santa Barbara branch of the Southern Pacific Railroad. The amount of available stone is said by Mr. I. N. Moore, Secretary and Treasurer of the Los Angeles Granite and Brownstone Company, to be "inexhaustible." The stone is at present brought by teams to the railroad and thence shipped to various towns in Southern California, to which section its use is now confined. If it can be brought to San Francisco it will furnish the architects of that city with an exceedingly valuable material for use, either by itself or with a lighter stone, for securing contrasts in color.

The Sespe brownstone has been used in the construction of the following buildings:

Y. M. C. A. Building, Los Angeles, Cal.	Entire front facade.
Bryson Block, corner Spring and Second Streets, Los Angeles, Cal.	First story and superstructure trimmings.
New Theater Building, Spring and Second Streets, Los Angeles, Cal.	Front facade.
Burdick Block, Spring and Second Streets, Los Angeles, Cal.	First story and superstructure trimmings.
Cohen Building, Spring Street, Los Angeles, Cal.	Trimmings.
Drew Block (P. O.), San Bernardino, Cal.	Trimmings.
Opera House, South Pasadena, Cal.	Trimmings.
Colonel Markham's residence, Pasadena, Cal.	Basement.
People's Bank, Pomona, Cal.	Trimmings.

SAN JOSÉ SANDSTONE.

About one cubic foot of this sandstone was purchased in San Francisco by the Mining Bureau, and sent to the University. It cannot be said, therefore, how fairly the specimen examined represents the stone.

Macroscopic.—This stone, which has entered so largely into the construction of many of the recent buildings erected in San Francisco, is of a handsome light yellow color, rather coarse and uneven grain, appearing in hand specimens to consist of grayish quartz granules of very variable size, and of very small, soft, dull whitish granules of kaolinized feldspar, between which a slight yellowish cement can be detected. Fragments of dark gray and bluish-black color, consisting mainly of soft clay, the largest of which was three quarters of an inch in diameter, are sparsely disseminated through the block examined, while both black and white mica scales are not entirely absent. A small fragment of the stone immersed in chlorohydric acid effervesces rather freely and continues to give off bubbles of carbonic acid for several hours, indicating the presence of a consider-

able portion of carbonate of lime in the cement. The stone is rather friable in small pieces, but in larger masses holds well together. It is a much better stone in this respect than the Altamont sandstone.

Microscopic.—The granular constituents are rather angular in shape, and vary in diameter from 2 m.m. to 0.05 m.m., the larger number being about 0.2 m.m. in diameter. Quartz is much the leading constituent, with the usual liquid cavities, and fixed or movable bubbles. Both orthoclase and plagioclase are present, the former, however, in larger quantity, and both are in the main very much decomposed into the dull, earthy kaolin granules visible to the unaided eye. The cement is a mere delicate film of kaolin, impregnated with carbonate of lime, that is hardly perceivable between the granules when viewing a polished surface in reflected light. The coloring matter, yellow limonitic ochre, is not distributed uniformly through the rock, but is in little isolated patches and particles here and there between the granules.

The specific gravity of the sandstone is 2.64, whence the weight of a cubic foot equals 165 pounds. The absorption of moisture is 1.23 per cent, of water, 5.13 per cent, and loss in solution of carbonic acid gas, 0.42 per cent. On exposure to acid fumes the color was leached out of a zone a quarter of an inch deep all over the fragment, and concentrated in streaks on the surface. Fissure joints were developed, not visable on the fresh stone, and fragments could easily be separated by the hand in places. The total loss by disintegration was 1.94 per cent. In the muffle furnace the stone suffered no change up to a bright red heat, except the change in color from its normal light yellow to a bright brownish red. Immersion in water while still hot failed to crack the stone in the least.

The crushing strength was determined on a single cube 1.796 in. x 1.850 in. x 1.99 in. (ht.), resulting in 2,400 pounds per square inch. As the bedding could not be recognized on the specimens utilized, the position of this cube with respect to the bedding of the rock cannot be indicated.

Occurrence.—No exact statement can be made concerning the occurrence of this stone. It has been used in the construction of the following buildings in San Francisco:

Pioneer Building, corner Fourth and Stevenson Streets	Trimmings above first story.
Lachman's Block, corner Market and Fremont Streets	Trimmings above first story.
Parke and Lacy Building, Nos. 21 and 23 Fremont Street	Trimmings above first story.
Starr King Building, Geary Street, near Stockton Street	Trimmings above first story.
History Building, No. 721 Market Street	Trimmings above first story.
Union Club Building, corner Post and Stockton Streets	Trimmings above first story.
McCleery's Building, Pine Street, between Sansome and Montgomery Streets	Entire building.
McCleery's Building, Sansome Street, between California and Pine Streets	Entire building.
Heller's Building, Sansome Street, between California and Pine Streets	Entire building.

ALTAMONT SANDSTONE.

The specimen of this stone that formed the basis of the following examination was obtained by purchase, in the same manner as the preceding building stone:

Macroscopic.—A light, grayish-yellow, fine-grained stone; showing, upon close examination, grayish-white quartz and feldspar granules and numerous minute black mica scales, with a scarcely perceptible cement between the granules. The grain is not entirely homogeneous, but shows a marked tendency to change from coarser to finer texture, within the limits even of a single hand specimen. Even in the finer grained portions an occasional gray or black granule of quartz, one or two millimeters in diameter, stands out prominently from the mass. The stone is very friable, the granules

being so loosely held together that mere rubbing with the hand detaches them somewhat freely. Such a stone is, of course, easily worked; but exposed edges and angles on cut blocks would rapidly wear if subjected to mechanical abrasion, or even to the ordinary mechanical disintegration of the weather.

Microscopic.—Thin sections of the rock, for microscopic examination, could be prepared only after hardening with Canada balsam, the fragments to be ground. The sections showed irregular, angular to subangular granules of quartz and feldspar, and what appear to be fragments of a soft, shaly rock, and scales of biotite mica. These fragments, or grains, vary in size from about half a millimeter down to the minute particles of the cement; but three distinct sizes may be distinguished—one third of a millimeter (about one fifth of the granules), 0.075 mm. (about three fifths of the granules), and 0.018 mm., the average size of the grains in the cement. The quartz granules are most numerous, and, as usual, have numerous liquid cavities with and without movable bubbles; and, in the latter case, frequently with bubbles very large in proportion to the size of the cavity. The feldspars, both ortho-, and plagio-clastic, are very plentiful, and are, in the main, particularly the plagioclase grains, noticeably undecomposed. Here and there a feldspar contains rectangular liquid cavities with fixed bubbles. The biotite mica scales are far less numerous than the quartz or feldspar grains. They are much decomposed, and appear to have furnished most of the ferruginous coloring matter of the stone. Rounded fragments of what appear to be a soft, shaly rock, are rather plentifully disseminated among the other constituents, and a few pyroxene granules were noted. The cement of the stone consists of very minute granules of all the preceding constituents, with argillaceous and some calcareous decomposition products, colored with yellow oxide of iron; it is very sparse in quantity.

The specific gravity of the stone is 2.68; weight of one cubic foot equals 167.7 pounds. The absorption of moisture equals 1.3 per cent; the absorption of water, 7.97 per cent; the loss in carbonic acid gas solution, 0.43 per cent. Exposed to strong acid fumes the color was entirely leached out of a superficial zone and concentrated in dark yellowish-brown streaks on the surface. The stone became still more friable than in its natural condition. The loss by disintegration was 3.43 per cent. This represents but a small proportion of the loss that would take place by mechanical disintegration on exposure to our beating winter storms. On exposure to bright red heat it cracked slightly, changed its color to a light reddish brown, and was unaffected on being plunged while hot into cold water.

The crushing strength was determined on a cube (the position of which with respect to the rock bedding cannot be given) 2.219 in. x 2.305 in. x 2.215 in. (ht.), resulting in 1,149 pounds per square inch.

Occurrence.—The quarries are presumably in the vicinity of Altamont, Alameda County, California. Altamont is a station on the Livermore branch of the Southern Pacific Railroad, which gives transportation facilities to any point where the stone may be used. So far as known the only building in which the stone has been used in San Francisco is that of the Cogswell Polytechnical College.

PENRYN GRANITE.

Macroscopic.—This is rather an evenly coarse-grained rock, in which one can recognize as constituents: Quartz, orthoclase, plagioclase, hornblende, and biotite; the proper scientific name for the rock is consequently

hornblende granitite. The quartz granules are easily distinguished from the feldspars by their darker smoky-gray color and conchoidal fracture. The feldspars are lighter colored than the quartz, very fresh looking, and are easily picked out by their fine cleavage surfaces. Even without a hand-lens one detects on careful examination the peculiar parallel striæ on many of these cleavage surfaces, that is characteristic of the triclinic feldspars. The hornblendes may be distinguished from the biotite scales by the absence of the peculiar pearly luster on their cleavage surfaces. Both are quite black, and they aggregate themselves closely together in irregular patches up to an inch or more in diameter, which are thickly disseminated through the rock. The mica scales have furthermore assumed a more or less parallel position throughout the rock, developing thereby a pronounced gneissoidal texture, and giving a very coarsely black and white mottled appearance to surfaces, broken parallel to the plane of this texture: a surface at right angles to the "rift" thus developed by the mica scales shows a much finer texture.

Microscopic.—Under the microscope one recognizes the usual granular texture of granites, all of the constituents having an irregular granular form, and interlocking in every direction. The quartz granules contain fluid cavities, sometimes with moving bubbles, sometimes without bubbles, and of a curiously irregular branching form. Of solid interpositions one has hornblende in minute, thick, short columns, colorless microlites with columnar extinction, and in at least one instance with zircon-like terminal faces, and hair-like forms thickly and confusedly disseminated through nearly every quartz granule.

The feldspars are both orthoclase and plagioclase, and appear to be present in about equal proportions. They are comparatively fresh, decomposition having just begun in some granules, worked in along the cracks and fissures of others, sometimes involving all of the substance of the very thin alternate members of a plagioclase compound granule, while in comparatively few granules have the secondary changes gone so far as to convert the entire central portion into an opaque mass of decomposition products. Included in the feldspars are magnetite granules, specularite scales of every conceivable distorted hexagonal form, minute hornblendes, colorless cylindrical microlites, and trichites, often in great profusion. Hornblende occurs both as an independent constituent and inclosed in the other constituents. It forms irregular columnar forms, usually closely associated with black mica, with which it sometimes combines in a definite way, its columnar axis lying in the cleavage plane of the mica. Its dark brown color is bleached out here and there in rounded patches, the bleached colorless portion containing thickly disseminated anisotropic scales and magnetite granules. The brown, unweathered hornblende is free from inclusions. An intermediate stage in which the hornblende has lost but a portion of its iron, changing from brown to green with separation of magnetite granules, is common. Biotite associates itself quite generally with the hornblende, and one single muscovite scale was observed. Apatite occurs quite commonly in delicate hexagonal needles, its sharply defined, minute hexagonal cross sections being most easily observed in the hornblendes.

The specific gravity of the granite is 2.77, whence the weight of a cubic foot equals 173.45 pounds. The absorption of moisture equals 0.06 per cent, of water 0.26 per cent, loss in carbonic acid gas solution 0.05 per cent. The loss of weight by disintegration in acid fumes was 1.09 per cent; every black mica scale on the surface of the exposed fragments bleached to a pearly whiteness, the iron that was dissolved out staining the rock slightly;

the feldspar granules looked perhaps a little duller, otherwise the stone was unchanged. On being heated somewhat above a bright red heat, the stone developed a complete network of deep-seated cracks; and, after immersion in water, the fragment could easily be crushed to powder in the hands.

The crushing strength, determined on a cube 1.304 in. x 1.290 in. x 1.210 in. (ht.), with the pressure applied at right angles to the "rift" or plane of gneissoidal texture, equals 5,232 pounds per square inch; and on a cube 1.294 in. x 1.204 in. x 1.285 in. (ht.), with pressure parallel to the "rift," equals 6,117 pounds per square inch.

The specimen examined was obtained by purchase in San Francisco.

Penryn granite has been used in the construction of the following buildings in San Francisco:

Eagle Block, northwest corner Pine and Davis Streets	Trimmings.
Lachman's Block, corner Market and Fremont Streets	First story.
Hobart's Building, Market Street opposite Second	First story.
S. F. Stock Exchange, Pine Street between Montgomery and Sansome	Entire building.
Real Estate Associates' Building, No. 234 Montgomery Street	Front.

ROCKLIN GRANITE.

The Rocklin granite is a fine-grained, white stone, with very small scales of black mica rather thickly and evenly distributed through it. White mica scale may be found on closer examination, but the biotite is far in excess. The smoky-gray quartz and the duller white feldspars are easily distinguished, and while the former are entirely irregular in shape, the sharply defined crystalline forms of the feldspars are very noticeable. Occasionally the biotite becomes a perfectly formed hexagonal scale; in the main, however, its contours are irregular. One specimen shows numerous pyrite crystals (sulphide of iron) on a surface which was evidently next to a quartz seam. Careful examination failed to detect pyrite disseminated through the body of the stone, but it is certainly very likely to occur there.

Microscopic.—The constituents revealed by the microscope are quartz, orthoclase, plagioclase, biotite, and muscovite. The quartz, as the youngest constituent, occurs in irregular granular form, filling out the space between the feldspar granules. Inclusions are not numerous; very few liquid inclusions occur, now and then with crystalline contour. Much more striking are the slender (probably) zincon prisms, ranging from 0.015 mm. to 0.003 mm. in thickness, beautifully terminated pyramidally on both ends. Still smaller colorless prisms passing finally into the most delicate hair-like forms are found in the quartz granules, which may, perhaps, belong to the same mineral. The only other inclusion noticeable is biotite in hexagonal or irregularly shaped brown scales. The feldspar is mainly orthoclase, and varies from the common habit of granitic feldspars in having definite crystalline contour. Many of the crystals show an exquisite concentrically zoned structure in polarized light, the zones failing to extinguish between crossed nicols simultaneously. Carlsbad twins are common. The inclusions are partly primary, and in part doubtless secondary, resulting from decomposition. They consist of liquid cavities, sometimes with movable bubbles, zircon(?) microlites, biotite, muscovite, and specularite scales, and minute scales, granules, and irregular patches, only in part anisotropic. These inclusions vary in quantity from very few to such dense masses as to make the crystal nearly opaque, and they are variously arranged in broad or narrow concentric zones or densely crowded

in the center, or filling the entire crystal except a narrow peripheral zone. Plagioclase granules are much fewer than the orthoclase, and their form and inclusions are entirely analogous to those of the orthoclase.

Of the two micas the black is present in much the greater quantity. Both occur as interpositions in the quartz and feldspars, as well as in thin or thick scales between the granules of the other constituents. Many of the biotite scales have partly or wholly changed color from brown to green without change of physical condition. The magnetite granules are rare and isolated or attached to a mica scale.

The specific gravity of the granite is 2.68, whence the weight of a cubic foot equals 167¼ pounds. The absorption of moisture equals 0.108 per cent; of water is 0.44 per cent; loss in carbonic acid gas solution is 0.1 per cent. The loss by decomposition and disintegration in strong acid fumes equals 0.68 per cent; thereby the black mica scales bleached white and the rock became slightly stained.

In the muffle this stone behaved quite like the Penryn granite, cracking not so deeply, however, and after immersion in cold water it could easily be crushed to powder in the hand.

The crushing strength of a *bed*-cube 1.407 in. x 1.275 in. x 1.275 in. (ht.) was 5,239 pounds per square inch. The specimen examined was purchased in San Francisco.

Rocklin granite has been used in the construction of the following buildings in San Francisco:

Hobart's Building, Market Street, opposite Second Street	Trimmings of upper stories.
Dunham, Carrigan & Co.'s Building, No. 18 Main Street	Trimmings.
Pioneer Building, corner of Fourth and Stevenson Streets	Trimmings.
Starr King Building, Geary Street near Stockton Street	First story.
New Odd Fellows Hall, corner Market and Seventh Streets	Trimmings.

MOUNT RAYMOND GRANITE.

The specimen of this building stone, purchased in San Francisco at the same time as the Rocklin stone, can, with difficulty, be distinguished from the latter. Color and texture are identical; the Mount Raymond stone is slightly richer in white mica scales. The microscopical characteristics of texture and of the mineral constituents are precisely the same for both stones. A partially completed chemical analysis fails to show a distinction. Both stones behave the same in all the tests to which they were submitted, the quantitative results being either identical or agreeing within the limits of error.

The following tests of the crushing strength were made on authentic Mount Raymond granite furnished by Mr. Abel Hosmer, one of the owners of the quarry, just before these notes go to the printer. The crushing strength of a *bed*-cube, 1.151 in. x 1.164 in. x 1.116 in. (ht.), was found to be 5,970 pounds per square inch; and of an *edge*-cube, 1.223 in. x 1.203 in. x 1.263 in. (ht.), equals 6,764 pounds per square inch.

It is, of course, possible that a granite exists at Mount Raymond, in Fresno County, that resembles as closely, as indicated above, another granite at Rocklin, in Placer County; but until I have authentic specimens direct from the respective quarries, I prefer to believe that blocks of stone from both quarries are liable to lose their identity in the stone yards of San Francisco.

A. WENDELL JACKSON,
Professor of Mineralogy, Petrography, and Economic Geology,
University of California, Berkeley.

UNITED STATES PATENTS IN CALIFORNIA.

REPORT OF COMMISSIONER OF GENERAL LAND OFFICE, UNITED STATES.

The following is taken from the "San Francisco Chronicle" of the issue of October 19, 1888. In order to ascertain whether the figures were correct, a letter was written to Hon. S. M. Stockslager, Commissioner of the General Land Office, who replied by telegram, a copy of which follows the article published by the "Chronicle." There has been no report of the Commissioner of the General Land Office received at the State Mining Bureau, as yet.

"CALIFORNIA LANDS.—WHAT THE OFFICIAL FIGURES SHOW.—ENTRIES FOR THE FISCAL YEAR.—AN INCREASE IN MILEAGE RATES FOR GOVERNMENT SURVEYS RECOMMENDED.

"WASHINGTON, October 18.—The report of the Commissioner of the General Land Office was to-day given out at the Interior Department. It shows that patents were issued during the past fiscal year for one hundred and seventy-two thousand five hundred and nine acres of land in California. There were patented in that State two hundred and forty-three homesteads, ninety-one commuted homesteads, one hundred and eighty-five preëmption cash entries, four hundred and twenty timber and stone entries, twenty-three desert land, thirteen warrant and scrip locations, four private cash sales of Government land, seventeen graduation cash, two miscellaneous cash entries, and two town sites, making one thousand patents in all.

"One coal land patent was issued involving forty acres, and ninety-five mineral and mill sites, and four hundred and ninety-seven acres of swamp land were patented, also two hundred and ninety-eight acres of land selected for agricultural colleges, and one hundred and sixty acres for public buildings; eight thousand eight hundred and eighteen acres of land consisting of private land claims, donations under claims in severalty, and scrip locations which are patented for California.

"The final entries for California are reported as follows: Two thousand and eighty final homesteads, one hundred and forty-three soldiers' and additional homesteads, one thousand two hundred and forty-one commuted cash, six thousand and eight redemption cash, one hundred and eighty-seven private cash, eight under the Act of June 15, 1880, fifteen warant and scrip locations, three hundred and six desert land, three thousand eight hundred and forty-six timber and stone, forty-eight timber culture, forty-seven miscellaneous, four coal, five hundred and eighty-two mineral and mill site; in all, fourteen thousand five hundred and fifteen. Original entries for California are pending in the General Land Office as follows: Thirteen thousand and eighty-nine homesteads, three thousand six hundred and four timber cultures, one thousand one hundred and seventy-nine desert, and nineteen mineral applications; in all, seventeen thousand eight hundred and ninety-one original entries.

"Respecting surveys of the public lands, the Commissioner says: 'Respecting California, eleven contracts and three sets of special instructions,

involving liabilities aggregating $2,034, were awarded and issued for public land surveys during the year. Owing to the low rates of mileage and the mountainous character of the lands embraced in many of the applications for the execution of the work, surveying operations were thus restricted.'

"In his annual report for the fiscal year ending June 30, 1888, the Surveyor-General referred to the number and character of the applications and petitions for surveys which were received at his office during the year, and to the present manner of inviting proposals for surveys; also, the inadequate rates now allowed for executing the same. The following extract from the report relative to the subject of rates is deemed of interest: It is next to impossible, furthermore, to secure bids for the performance of Government work at the existing legal rates of mileage, viz., $5, $7, and $9 per mile, respectively, for sections, townships, and meander lines. The lands yet remaining unsurveyed in California are chiefly hilly, mountainous, and timbered in character, and no surveyor can take a contract at rates so low and make enough to pay the expenses of his camping outfit alone. Such inadequate rates must certainly have a tendency to make deputies hurry over their work, and to accept assistance from interested parties contrary to regulations. Adequate compensation must be paid before the public surveys can be done expeditiously and honestly."

WASHINGTON, D. C., October 26, 1888.

WM. IRELAN, JR., *Esq., care of State Mining Bureau, San Francisco, California:*

Report for year ending June 30, 1888, shows two thousand nine hundred and ninety-four acres patented to California for Agricultural College purposes. "Chronicle's" other figures correct. Fourteen hundred and ninety-eight additional patents have been issued for lands in California since July 1, 1888, covering two hundred and thirty-nine thousand six hundred and eighty acres.

S. M. STOCKSLAGER, Commissioner.

There are ten United States Land Offices in California, located at the places below stated. By reports received from the Register of each office, there appears to have been the following number of mineral entries in each office from the date of the first Mining Act, July 23, 1866, to September, 1888, viz.:

San Francisco	109
Marysville	231
Humboldt	82
Stockton	368
Visalia	15
Sacramento	1,260
Independence	216
Los Angeles	73
Shasta	232
Susanville	56
Total	2,642

WATER RIGHTS.

Section 1422 of the Civil Code of the State of California, which reads as follows: "The rights of riparian proprietors are not affected by the provisions of this title." By the Act approved March 15, 1887, the foregoing section was repealed, as follows:

An Act to repeal section numbered fourteen hundred and twenty-two, of title eight, of part four, of division second, of an Act entitled an Act to establish a Civil Code, approved March 21, 1872, and to reserve from the operation of said repeal rights already vested.

[Approved March 15, 1887.]

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. Section numbered fourteen hundred and twenty-two, of title eight, of part four, of division second, of an Act entitled an Act to establish a Civil Code, approved March twenty-first, eighteen hundred and seventy-two, is hereby repealed; *provided*, that the repeal of this section shall not in any way interfere with any rights already vested.

SEC. 2. This Act shall take effect from and after its passage.

THE ALIEN ACT.

An Act to restrict the ownership of real estate in the Territories to American citizens, and so forth.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be unlawful for any person or persons not citizens of the United States, or who have not lawfully declared their intention to become such citizens, or for any corporation not created by or under the laws of the United States, or of some State or Territory of the United States, to hereafter acquire, hold, or own real estate so hereafter acquired, or any interest therein, in any of the Territories of the United States or in the District of Columbia, except such as may be acquired by inheritance or in good faith in the ordinary course of justice in the collection of debts heretofore created; *provided,* that the prohibition of this section shall not apply to cases in which the right to hold or dispose of lands in the United States is secured by existing treaties to the citizens or subjects to foreign countries, which rights, so far as they may exist by force of any such treaty, shall continue to exist so long as such treaties are in force, and no longer.

SEC. 2. That no corporation or association more than twenty per centum of the stock of which is or may be owned by any person or persons, corporation or corporations, association or associations, not citizens of the United States, shall hereafter acquire or hold or own any real estate hereafter acquired in any of the Territories of the United States or of the District of Columbia.

SEC. 3. That no corporation other than those organized for the construction or operation of railways, canals, or turnpikes shall acquire, hold, or own more than five thousand acres of land in any of the Territories of the United States; and no railroad, canal, or turnpike corporation shall hereafter acquire, hold, or own lands in any Territory, other than as may be necessary for the proper operation of its railroad, canal, or turnpike. except such lands as may have been granted to it by Act of Congress. But the prohibition of this section shall not affect the title to any lands now lawfully held by any such corporation.

SEC. 4. That all property acquired, held, or owned in violation of the provisions of this Act shall be forfeited to the United States, and it shall be the duty of the Attorney-General to enforce every such forfeiture by bill in equity or other proper process. And in any suit or proceeding that may be commenced to enforce the provisions of this Act, it shall be the duty of the Court to determine the very right of the matter without regard to matters of form, joinder of parties, multifariousness or other matters not affecting the substantial rights either of the United States or of the parties concerned in any such proceeding arising out of the matters in this Act mentioned.

Approved March 3, 1888.

THE AMENDMENT OF THE ALIEN ACT.

The Act entitled 'an Act to restrict the ownership of real estate in the Territories to American citizens,' etc., approved March 3, 1887, shall not relate to or in any manner affect the title to mineral lands or mining claims in the Territories of the United States, which may be acquired or held under the mineral land laws of the United States, nor to mills or other reduction works or property used in the production of metals from said mineral lands or claims; but as to all such mineral lands, mining claims, mills, reduction works, and other property, the laws of the United States and the Territories shall be, until changed by Act of Congress or any Act of the Territorial Legislature. the same as though said Act had not been passed.

First session of the Fiftieth Congress, 1888.

IMPORTS OF MINERALS AND MINERAL PRODUCTS.

[From the annual report and statements of the Chief of the Bureau of Statistics, on the Commerce and Navigation of the United States, for the fiscal year ending June 30, 1887.]

The following statements have been extracted, as regards to the imports into the port of San Francisco, of minerals and mineral products:

Brass, and manufactures of, value	$19,626, dutiable.
Cement	211,533 barrels, dutiable.
Clays and earths of all kinds, including kaolin	153 tons, dutiable.
Coal, bituminous	616,398 tons, dutiable.
Coke	24,792 tons, dutiable.
Copper, pigs, bars, ingots, old, etc.	600 pounds, dutiable.
Copper, all other manufactures of, value	$1,010, dutiable.
Earthen, stone, and chinaware, value	$116,495, dutiable.
Glassware, bottles, etc., value	$39,433, dutiable.
Glassware, cylinder, crown, and common windows	6,151,744 pounds, dutiable.
Iron ore	171 tons, dutiable.
Pig iron	8,670 tons, dutiable.
Scrap—for remanufacture—wrought and cast	20,019 tons, dutiable.
Bar iron, rolled and hammered	1,951,076 pounds, dutiable.
Railway bars of steel	401 tons, dutiable.
Hoops, bands, strips, plates, sheets, etc., of steel	77,259 pounds, dutiable.
Steel in forms not elsewhere specified	25,292,325 pounds, dutiable.
Sheet, plate, and tagger's iron	155,026 pounds, dutiable.
Tin plates, terneplates, or tagger's tin	26,595,846 pounds, dutiable.
Wire rods, screws, nails, rivets, etc., iron and steel	2,408,629 pounds, dutiable.
Wire and wire rope, iron and steel	385,455 pounds, dutiable.
Anvils, axes, forgings, of iron and steel	46,798 pounds, dutiable.
Chains, of iron and steel	94,040 pounds, dutiable.
Cutlery, value	$23,968, dutiable.
Files, rasps, floats, file blanks, etc., value	$211, dutiable.
Firearms, value	$22,074, dutiable.
Machinery, value	$3,233, dutiable.
Needles, value	$2,655, dutiable.
All other manufactures of, value	$79,680, dutiable.
Lead, value	$1,987, dutiable.
Chloride of lime, or bleaching powder	447,499 pounds, free.
Marble, value	$9,984, dutiable.
Plaster of Paris, sulph. lime	1,446 tons, free.
Plumbago	944 cwts., free.
Phosphates—fertilizers	925 tons, free.
Nitrate of potash—saltpeter—crude	45,693 pounds, dutiable.
Salt	13,394,297 pounds, dutiable.
Sulphur, crude	3,176 tons, free.
Stone, value	$9,287, dutiable.
Bicarbonate of soda	316,450 pounds, dutiable.
Carbonate of soda—sal soda—etc.	3,559,950 pounds, dutiable.
Caustic soda	1,444,041 pounds dutiable.
Nitrate of soda	17,560,353 pounds, free.
All other sorts of soda	124,536 pounds, dutiable.
Tin, in bars, blocks, or pigs, grains or gran	1,456,799 pounds, free.

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ERRATA.

Page 201, line 18 from top, for "inch," read "mesh."

Page 224, line 17 from top, for "southerly," read "southeasterly."

Page 233, line 18 from bottom, for "Key West," read "Keynote."

Page 245, line 2 from top, for "one," read "our."

Page 264, line 8 from bottom, for "southeast," read "northeast."

Page 305, line 14 from top, for "claim," read "chain."

Page 322, line one, top sketch, for "State," read "slate."

Page 368, line 29 from top, for "fracture planes," read "fractured zones."

Page 373, line 15 from top, for "1887," read "1878."

Page 379, lines 12 and 13 from top, omit all after "silver" in line 12, to and including "silver" in line 13.

Page 384, line 18 from bottom, for "southwest," read "south, west."

Page 387, line 8 from top, for "clay, bowlders, quartz," read "clay and bowlders of quartz."

Page 390, line 23 from top, "three hundred," read "seven hundred."

Page 393, line 4 in foot note, for "dates" read "data."

Page 395, line 5 from top, for "1887" read "1877."